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RAPID TRANSIT FOR NEW YORK.

When Governor Flower last week, reluctantly acting under the pressure of public opinion, signed the Rapid Transit bill for New York City, he relieved his feelings by pointing out that after all the measure was so encumbered that it was doubtful if the public would derive any benefit from it. The opposition of politicians everywhere to underground projects of rapid transit is very significant. In such schemes they see no visions of franchises to be bargained for, no chance of employment of "pulls" in condemnation and damage proceedings, no campaign and personal contributions to be extorted for immunity from interferences in the operation of the property. The fact that underground roads are the only solution of the rapid transit problem plays no figure with our rulers—how to accumulate the greatest amount of "boodle" for themselves or their followers is the only problem that interests them, and to this the building of elevated railways offers a more satisfactory solution. The friends of rapid transit do not despair of finally overcoming the numerous obstacles placed in their way, and as they are committed to the underground system, which implies the adoption of electric traction, they have the warmest sympathy of all connected with the electrical industries.

THE CANDLE POWER OF ARC LAMPS.

Prof. Mendenhall, at the recent Washington National Electric Light Convention, when discussing the subject of the rating of arc lamps, humorously referred to the statement of a foreign electrician that in America the candle power of arc lamps was arrived at by taking a photometric measurement from each of the cardinal points of the compass, adding the results together and calling the sum the candle power of the arc. That the original author of the witticism or any of the gentlemen of the Association really believed there was any foundation in fact for this statement we very much doubt, but we are now able to announce that there is at least one "electrical expert" who not only believes in that novel method of determining the candle power of an arc, but has actually expressed himself officially to that effect. The Board of Public Works of a city not so very distant from New York recently applied for expert advice relative to a clause in a street lighting contract with a local electric light company, and the following is the manner in which it was enlightened: "The arc lights are hung at the street intersections, and each one throws its light in four directions; 2,000 c. p. of lights on each of the four streets cannot, therefore be expected. An arc light which throws 500 c. p. of light along each of four streets is a 2,000-c. p. lamp, as called for in the contract."

THE PRACTICAL MAGNETIC UNITS.

In a recent number of "L'Industrie Electrique" Prof. Hospitalier welcomes the provisional names recently adopted by the American Institute of Electrical Engineers for the C. G. S. magnetic units, and states that he will introduce them into the coming edition of the "Formulaire de l'Electricien"—a work which is accepted and used as a standard by electricians in every country in the world, and will therefore give a wide and authoritative circulation to the new practical system. He refers to the great need of names that existed for the designation of the principal magnetic units, and most strongly counsels, as a matter of great practical importance, the adoption by electricians of the gauss, gilbert, weber and oersted, "in spite of opposition from the savants of pure theory, who have no need to give a concrete

form to their ideas and formulas." Scientific men in America, fortunately, are not separated into castes antagonistic to each other, and as our "savants of pure theory," if, indeed, that narrow term is at all applicable here, do not consider "practice" as unworthy their consideration, we need not in this country fear the opposition referred to by Prof. Hospitalier. The great benefit to be derived from the new terms must have impressed itself upon the audience at the recent Institute meeting at Philadelphia when in the discussions they had contrasted the expressions "15,000 lines per square centimetre" or "15,000 C. G. S. lines per square centimetre" with "15 kilogausses."

THE JUBILEE OF TELEGRAPHY.

Fifty years ago, on May 24, 1844, the first public message was received in the United States by the Morse recording telegraph, having been sent over a line erected between Baltimore and Washington. With those wonderfully appropriate words, "What hath God wrought," was inaugurated nothing less than a new era of civilization, and a blessing conferred upon man to which the inventions of writing and printing were only comparable. From the two temporary offices used on that memorable day have sprung the little less than half million now distributed over the face of the earth, and the progeny of that first message now numbers almost 300,000,000 annually. The beginning of the growth which has culminated in these figures can rightly be ascribed to the event mentioned, for it gave the commercial impetus which resulted in the rapid spread of telegraphy over the world, though the only invention concerned was the recording instrument then used. Previous to 1837, the date of publication by Morse of his invention, numerous experimental forms of electric telegraphs had been devised, and in that same year the needle telegraph, or alternate right and left deflection instrument, was made practically perfect, and put in actual operation in 1838 on the line of the London and Blackwall Railway in England by Cooke. It is worthy of note that while this latter system of telegraphy, but with one instead of two needles, is yet much used in England, particularly in the auxiliary offices of large cities, the Morse recorder has become largely a thing of the past. The service the latter rendered, however, by accomplishing what was then considered to be the sine qua non of practical telegraphy—the actual recording of messages—was an immense one, and, united to the no less great services of the inventor through his indefatigable efforts in pushing the invention commercially, justly entitle Morse to be considered the "Father of Practical Telegraphy," though, at the same time, the work of Henry, Davy, Cooke, Vail and others should receive a due share of credit.

THE INSTITUTE AND UNDERWRITERS' ELECTRICAL INSPECTION RULES.

Owing to its national character and the professional standing and influence now possessed by the American Institute of Electrical Engineers, too much care cannot be taken in lending the weight of its authority to measures asking its indorsement. The necessity of exercising the greatest caution in this respect was illustrated at the recent annual meeting at Philadelphia, where the Institute was asked to adopt a set of "Standard Rules for Electrical Construction and Operation" prepared by a committee of the National Electric Light Association. Though the intrinsic value of the rules is undoubtedly very great, and the services of the National Electric Light Association in taking up the subject of insurance rules have had a most valuable effect in the past, the result of an indorsement by the Institute would make it a party to a feud with the Underwriters' Association of Electrical Inspectors, a number of whom are members of the Institute. While we cannot indorse the action of that body in adopting almost bodily, as they did, the former rules of the National Electric Light Association without giving the proper credit, nor the narrow policy pursued in excluding from its deliberations some who should have been invited, yet its work should first be impeached before the Institute takes an action whose effect would be to injure it. Formerly electrical inspection was in a chaotic state, almost every insurance inspector having his own set of rules. In one place one set of rules was enforced and a different set in another place, and all subject to constant change without notice. In those days it was war when the contractor and inspector met over a piece of work, not the least cause being the facility with which one code of rules could be set up against another. The Electrical World referred editorially to this matter almost two years ago as follows: "The present state of electrical insurance inspection is extremely unsatisfactory, and this is largely due to the non-uniformity of rules and methods. When one inspector under one set of rules can pass work that another inspector under his rules would have to condemn, the result can only be to bring electrical insurance inspection into disrepute generally, and render the duties of the inspectors difficult and disagreeable to perform. Perhaps the greatest boon from the adoption of a uniform set of rules would be to reputable electric light contractors, who are now harassed by the different sets of rules in force and who, under the healthy system the new regime should inaugurate, would have some protection from the horde of incapables now doing shameful electrical work." To obviate this great source of trouble, which bore almost equally on the inspector and contractor, a code of rules based upon the excellent one of the National Electric Light Association was, after long and careful deliberation by a body composed of underwriters' electrical experts, adopted more than a year ago, and is now used with scarcely an exception by all the various underwriters' associations of the United States. If the effect of the adoption of a set of insurance rules by the Institute would be to cause the underwriters to substitute it for their own, then the consideration of such an action would of course be unobjectionable. But the latter would probably do nothing of the kind, as they would claim, and with reason, that it would be absurd for them to thus confide to others the protection of the immense money interests they have at stake in the matter. With two sets of rules, one having the high professional indorsement of the Institute, there would be a return to the old state, and as the underwriters, unlike the Institute, would have the power to enforce their rules, the only result would be a highly unsatisfactory state of affairs to both electrical contractor and insurance inspector. Should any of the present underwriters' electrical rules be unjust to electrical interests, then it would of course lie within the province of the Institute to attempt to bring about the necessary change, and it is probable that any recommendations on its part would receive proper consideration. By co-operation in an advisory capacity, it could render valuable service to both the electrical and insurance interests, but it would not be proper policy for it to adopt a rival set of rules which necessarily, as remarked before, could not be enforced and would only lead to the renewal of a bitter warfare between two interests which had become largely harmonized. The report of the Institute committee was against the summary adoption of the rules submitted, but as it was not discharged the matter may come up again.

Production of Copper.

The "Engineering and Mining Journal," in a table compiled by its editor, Richard P. Rothwell, on the mineral production in the United States in 1892 and 1893, gives the quantity of copper mined in the latter year as 322,585,500 pounds, valued at $34,677,940 at the place of production. This shows a falling off of 2,914,500 pounds, and $2,038,460 from the figures of the previous year.

SWITZERLAND AS THE PRESENT ELECTRICAL CENTRE OF EUROPE

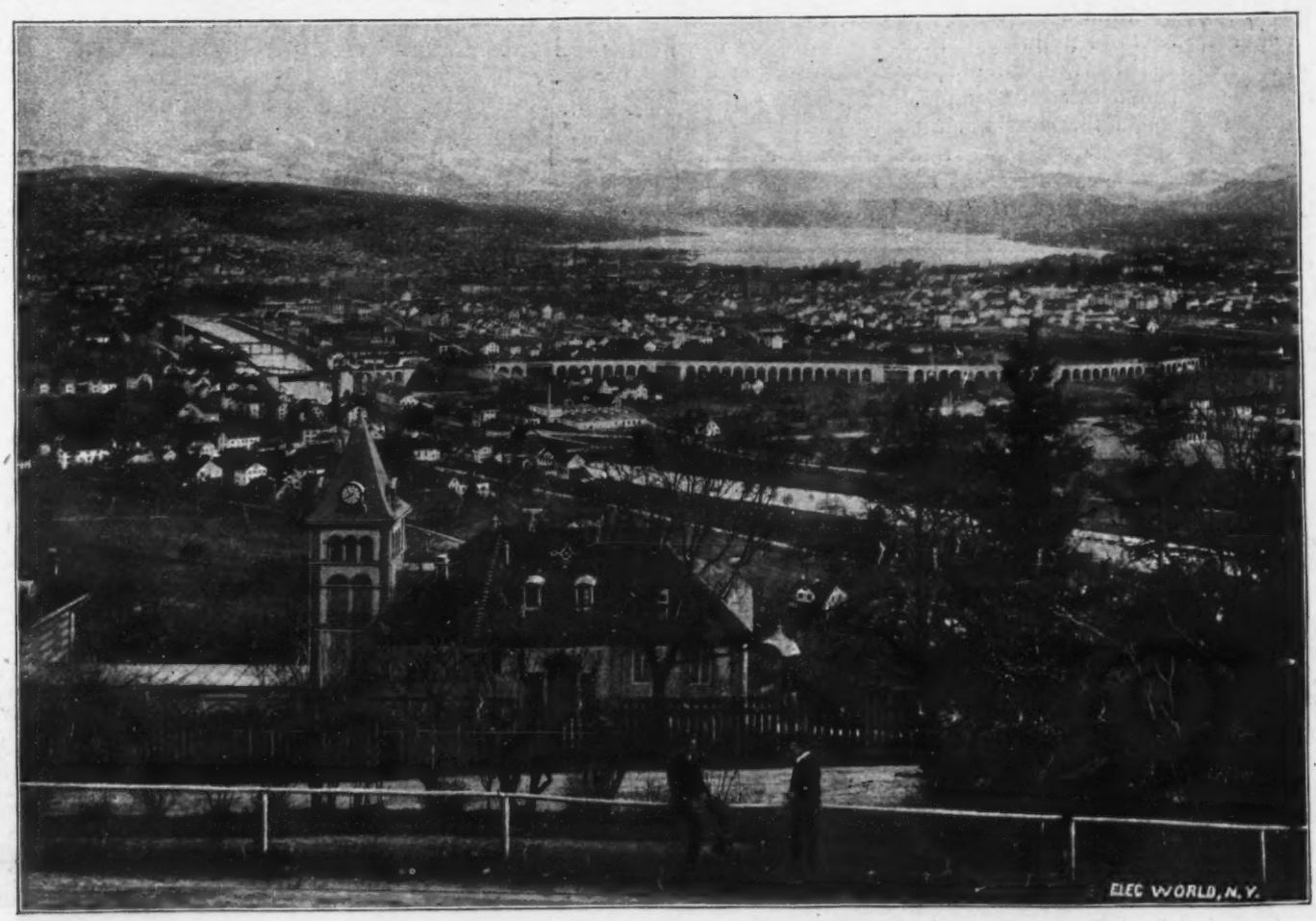
BY FREDERICK BATHURST.

The above title may be taken either literally or in metaphor, as it may appeal to the individual reader, but the writer asks permission to use it as the heading under which, through the medium of The Electrical World, he can put before American electricians some particulars of one or two of the more recently installed electrical plants of Switzerland. It is thought that these representative installations, while presenting in themselves novel features of considerable interest, also indicate in no small degree the direction in which the most approved electrical practice tends to advance.

Switzerland, it is true, is small, even as a centre minute in size, with its 3,000,000 people cooped up within an area one-third that of New York State, for example, and it has already become to be generally recognized as a field wherein there is considerable electrical activity, but it is perhaps only the few electricians who may have visited this lovely little country, either for health or pleasure, who have noticed how thoroughly progressive the Swiss are in their electrical work, how high they stand in comparison with Americans or Europeans, and what praise should be accorded to them for the design, execution and stability of their installations.

As a further reason, for introducing this theme just before the time arrives for arranging the summer holiday tour, we have not before us this year the distraction of a Columbian Exposition, but instead a Continental display—Antwerp—and perhaps many may be induced to extend their annual peregrination so as to include this, in which case I would suggest the slight further extension into the Swiss mountains, as one that would well repay the electrical explorer, both hygienically and scientifically.

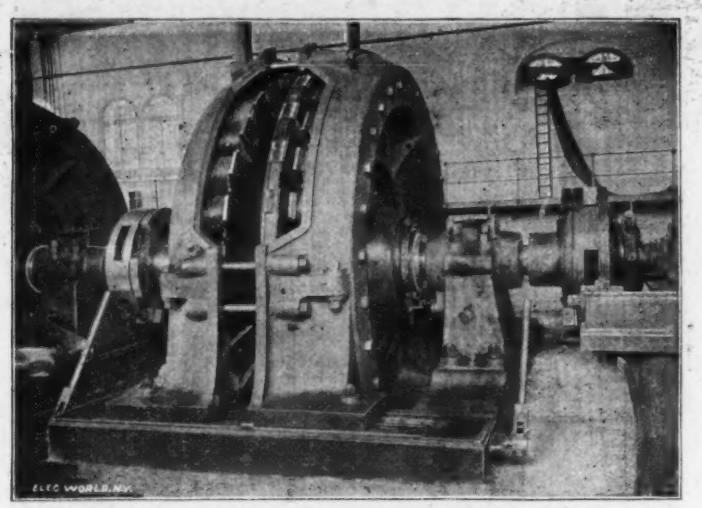
Entirely surrounded by large countries, France, Germany, Austria and Italy, all nations which are impoverishing themselves by their dread and jealousy of each other, each maintaining large armies of non-productive workmen, little Switzerland, with enlightened policy, prefers to remain impartially neutral to all, and allow its people to live as producers instead of soldiers. Mother Nature, although so generous of wealth in other potentialities, would seem to have forgotten to provide the all-important natural rescource, coal, which would tend to confirm the political policy, but possibly only to give cause for the remark that the Swiss people combine to their advantage, as their national characteristic, the artistic culture of the Italian, the energy of the Frenchman and the perseverance of the German, and to stand as a further proof that the harder natural conditions



THE TOWN OF ZURICH, SWITZERLAND.

always combine to bring forth a type of man suited to rise superior to the physical deficiencies. In any case, the absence of coal renders necessary the utilization of the substituted resources, and develops the numerous water powers.

Electricity has taken its place as the medium, par excellence, by which power may be transformed and transmitted, so that it is not unnatural to find it here receiving



200-KW. ALTERNATOR COUPLED TO TURBINE.

rapid and extended application. The conditions are also such that not only is capital more willing to find investment in the neutral field, but a larger market is open to the productions therefrom, for none of its neighbors will buy from another a commodity which it may by natural or created advantage be better fitted to supply, for fear that by so doing it may benefit the rival and thereby indirectly injure itself. Any extension of demand that Switzerland receives for its productions from these causes again reacts to promote further developments in its initial powers and again increases the demand for electrical apparatus.

In order to show the high standard that such apparatus has attained, and the engineering skill and judgment with which it is installed, I propose to instance as typical installations—First, for light, the electric lighting of the town of Zurich; second, for power, the transmission to and installation in the Oerlikon Electric Works; third, for electric railways, the Zurich-Hirslanden Street Electric line.

I.—THE ELECTRIC LIGHTING OF THE TOWN OF ZURICH.

This installation is of considerable interest, from the fact that although in a town that cannot lay claim to be in the first rank as regards number of inhabitants (Zurich has a population of 110,000 people), it is at present the largest electric system of supply yet installed in which a high pressure alternating current is distributed through a complete network of underground mains arranged in districts, wherein are placed separate transformer stations, and from which, as centres, a low pressure supply is obtained. It is again more interesting because it is the utilization of a water power.

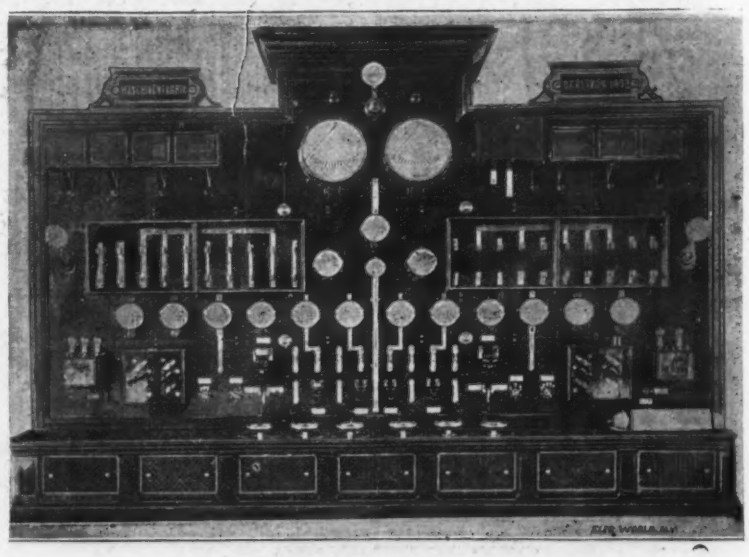
Coming into the centre of the town by the railway, it is but a few minutes' walk to the offices of the "Elektricitaetswerk der Stadt Zurich," on the Bahnhof Bridge. It is here that the engineers can be found, and all information relating to the work will be most willingly given. I wish to record my indebtedness to the engineer-in-chief, Herr W. Wyssling, and his able assistant, Herr Hans Buechler, for the courtesy and willingness with which they placed all the particulars and privileges before me, and to say that it is a pleasure in store for any electricians who intend to visit Zurich to meet these gentlemen.

Like all the most enterprising and enlightened municipalities, the town council of Zurich has been wrestling with the question of electric lighting for many years past, although (and perhaps in this respect unlike other municipalities) they, from the very first, decided that any work which was done should be in the hands of the municipality itself.

Experiments were made with various systems and technical assistance was asked from the best known experts in Switzerland. Ultimately, from among the various plans submitted, the choice was made in April, 1890, in favor of an alternating system having one central station and many transforming centres, but it must in fairness be said that this choice was largely determined by the argument that, if afterward necessary, these same transforming centres could be conveniently utilized as centres, with alternating motors, from which district accumulators for a direct supply system could be charged. The first accepted plans also comprised a direct current series system of arc lighting, the lamps on which were to be placed on the principal streets and lake front. Passing through the usual delays and vicissitudes, the system, as it now stands, started to supply current in August, 1892.

The same building which contains the electrical department's offices contains also those for the municipal gas supply, and it is a very significant feeling that takes possession of the visitor as he stands in these offices and sees side by side all the accessories needed for the installation of either gas or electricity and learns that the departments keep in touch with all manufacturers of these goods, buys from them at the best discounts and is able to supply the town consumer with any material he may require even more advantageously than he can procure them for himself elsewhere. In reality these showrooms are in the nature of a general sample room where the buyer can see all types of fittings, compare their price and select from the stock those having most merit. Will not this fact in itself help along municipal supply?

Leaving the offices and proceeding to the central station we find that the town authorities are again in an exceptionally advantageous position, for the electrical machinery is placed under the same roof as the turbines and pumps providing the city water supply. This pumping station is situated 1 1-4 miles away from the lake on the River Limmat, which forms the northern outlet for the waters collected in the Lake of Zurich, one of the many Swiss lakes caused by the



THE SWITCHBOARD.

melting snows of the northern Alps. The view shows the town lying at the end of the lake, with the Alps behind to the south. In this view on the left, between the railway bridges, can be seen the canal, about half a mile long, which has been constructed so as to divert the river through the pumping station. An adjustable dam is thrown across the river, so that as much water can be thrown into the canal as desired.

At the station end of the canal a fall is obtained, which varies from 6 feet to 11 1-2 feet, according to the season of the year.

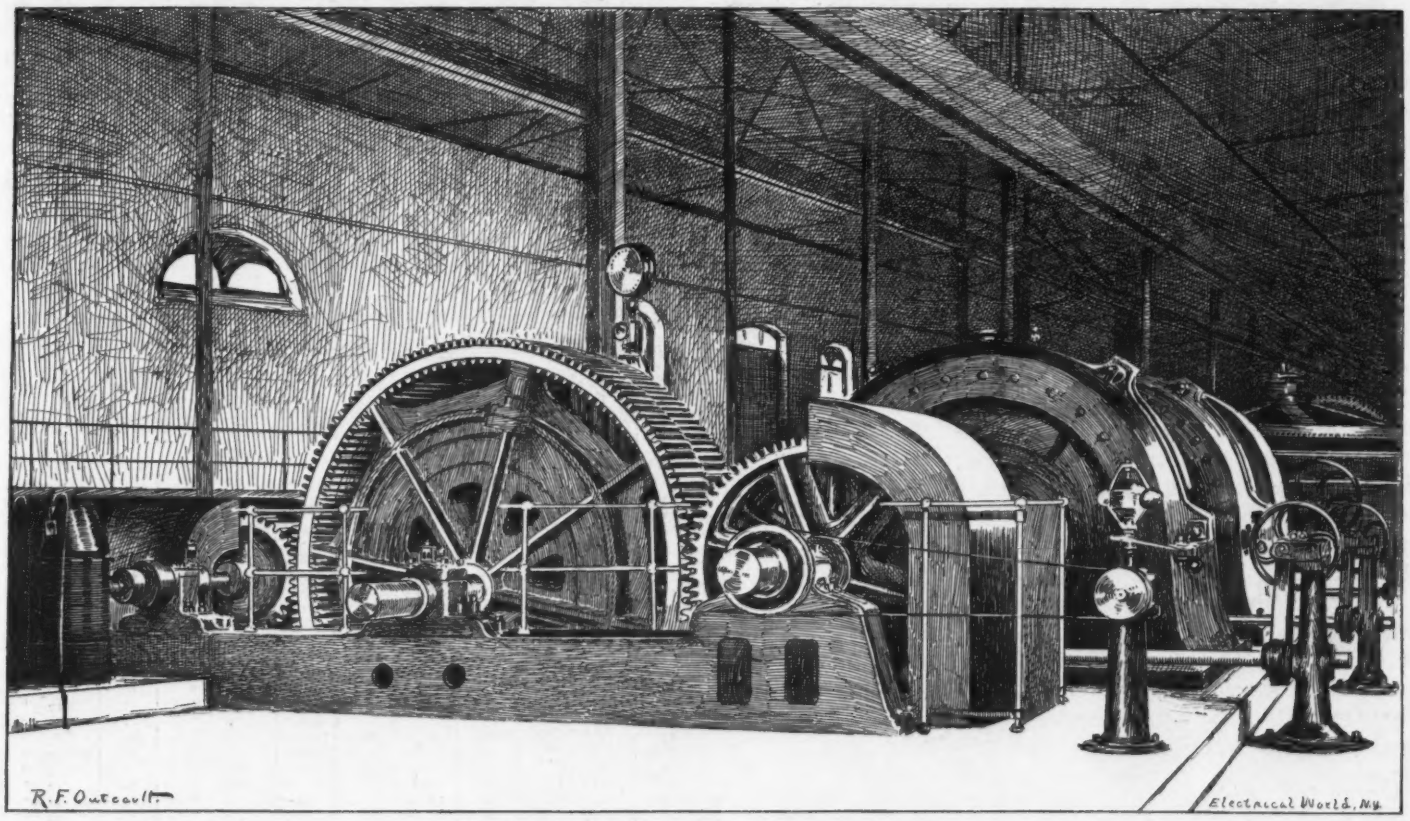
Conditions are the reverse of those obtaining in America, inasmuch as in summer, owing to the rapid melting of the Alpine snows, there is always an excess of water, whilst in winter it has sometimes happened that the water supply was so diminished that it was necessary to fall back upon the steam reserve in the station for a part of the electrical power.

The pumping station is a fine, substantial brick and iron building, some 400 feet long and 80 feet wide, beautifully designed for the purpose it fulfills. A transverse overhead crane runs the length of the building, so that the heavy parts of the turbines and pumps can be handled without difficulty. Eight 150-h. p. turbines of the three-tier Jonval type drive on to a main countershaft and operate as many duplex double acting pumps. Each pump can be driven by its opposite turbine or from the countershaft, as most convenient. The water of the canal is utilized by means of these low pressure turbines and pumps to draw water from an intake away in the lake and force it up into a series of three closed reservoirs on the Zurichberg. From these reservoirs, which have a combined capacity of 2,500,000 gallons, the town is supplied. The capacity of the pumps is considerably in excess of the requirement for this work, so that when electric lighting was contemplated, it is only to be supposed that attention was given to this fact. Strangely opportune also was the knowledge that of the reservoirs on the mountain, the highest and largest was not in use, for at the time of a fever epidemic in the town, 10 years previous, the source of the disease had been traced to this large open basin, and it was then abandoned. It is this reservoir, now forming a hydraulic accumulator, that makes the electric lighting of Zurich possible. After the pumps have filled the closed drinking water reservoirs they are turned on to the large open one, which has a capacity for 2,640,000 gallons and is 525 feet above the station. From this artificial source the power required for driving the dynamos at night is derived.

The electrical generating plant proper is arranged together at the northern end of the building, and consists of large alternators (2,000 volts) driven by high-pressure turbines. The turbines were made by Escher Wyss & Co., of Winterthur, and are designed to work under a pressure of 225 pounds per square inch. When under full load, 300 h. p., they have a commercial efficiency of 75 per cent., and are arranged vertically to drive directly on to the horizontal shaft of the generator. As it is undesirable to draw upon the high-pressure reservoir during the day for the small load, the station countershafting is arranged so that the generators can be driven from two of the low-pressure turbines (worked from the canal), each of which is then disconnected from its pump and the regular water supply. A 300-h. p. steam engine, condensing, working at 112 pounds steam pressure, made by Sultzer Brothers, is also provided, more as a reserve for the winter months, so that in case the high-pressure reservoir is too severely taxed this can also be coupled on to the shafting to assist either day or night load.

The station, then, it can be seen, may be run with steam engine, high-pressure or low-pressure turbines, either individually or all assisting one another.

Below is an interior view of the station as seen from the switchboard. It shows the ends of the main countershafting (in the centre), the alternator and high-pressure turbine shafting and the subsidiary shafting for exciters, and also the method of gearing.



INTERIOR OF THE ZURICH STATION.

At present four 200-kw. generators are installed, three of these are usually sufficient for the night load, so that one can be left in reserve for emergencies. In addition to these a small generator of 100-kw. capacity has been placed in the station temporarily for the day load. This generator is belted to the main countershaft.

The 200-kw. generator gives 2,000 volts and 100 amperes when running at 200 revolutions per minute, and having 30 poles produces 6,000 reversals per minute or 50 cycles per second. They are of the Kapp type, with stationary exterior field ring, the rotating armature carrying the high potential coils. The current is collected on copper rings on either side of the armature, so that any danger to the at-

tendants is minimized. Under full load a commercial efficiency of 88 per cent. is obtained. The excitation required is 2 1-2 per cent. Two exciters, Manchester type, ring armature, continuous current machines, are used, which, when running at 400 revolutions per minute, develop 100 volts and 200 amperes. One of these is held as a reserve. They are driven either from the main countershafting or two small high-pressure 30-h. p. turbines. The commercial efficiency of the exciters is 86 per cent. at full load.

The 100-kw. alternator is self-contained, its exciter being on the armature shaft. It has 18 poles and runs at 335 revolutions per minute, so as to produce 50 complete cycles per minute. All the generators were manufactured by the Oerlikon Works.

During the hours that the output is largest it is necessary to connect the generators in parallel and this station again presents the interesting feature of machines of different sizes and design running together. The "throwing in" would also seem to present exceptional difficulties from the fact that one generator is "belted" while the others are geared rigidly. The cut shows the 200-kw. generator with half the frame drawn out of position (in order to permit an examination of the armature coils), and the crown type clutch, by which the armature and turbine shafts are connected together.

The same type of clutch is used to throw the generators together in parallel. It consists of two open "star" plates, one rigidly keyed to the turbine and the other to the armature shaft, and a sliding "jaw" plate, the teeth of which pass in between the arms of the star plates. It is evident that as the generators must be thrown together in like phase, all the star plates must be keyed to the shafts in the same relation to the armature coils. No trouble whatever is experienced in "switching in" together, the operation taking but a few moments, watchfulness and precision being the requirements of the operator.

Placed conveniently near the generators is a handsome switchboard (see illustration); from this the generating plant is completely under control. The board contains double-pole switches and fuses, ammeters and voltmeters for each generator. Low potential voltmeters are employed, the converters for them being placed on the top of the board. Measuring instruments for the exciting machines, a voltmeter showing the potential in the city and automatic relays for effecting the requisite regulation, are also included.

The field resistance boxes of all the machines are arranged at the bottom of the board. To the right can also be seen the automatic field regulator, power for moving the contact lever being obtained from a diminutive high-pressure turbine, which consumes about 10 litres (2.2 gallons) of water per minute.

(To be continued.)

The Chicago Local Meeting of the A. I. E. E.

The local meeting of the American Institute of Electrical Engineers at Chicago on Thursday of last week was even a greater success than either of the preceding ones, and, in connection with the previous meetings, not only vindicates the wisdom of those who struggled, at first against odds, to bring about the establishment of local meetings, but also furnishes ample excuse for the almost complete reversal of opinion of those who formerly opposed that measure. Prof. Stine's smaller lecture room at Armour Institute, where the former meetings have been held, had to be abandoned, as the seating capacity is only 50, and even the larger lecture room used, seating 100, was not large enough to hold the audience present. Extra chairs were added, but still a number of those in attendance were compelled to stand; by actual count there were about 140 present, about 40 of whom were Armour Institute students. Some 50 invitations were sent to neighboring central station men and others interested in station apparatus, and 50 to prominent members of the now defunct Chicago Electric Club. The Armour Institute people took pains to provide everything needed. It was not known until late that a 1,000-volt current would be needed, and just previous to the meeting a dynamo was set up and extra wiring done in order to supply it.

The lecture, with the accompanying experiments, passed off very satisfactorily. The discussion which followed lasted for an hour, and was participated in by Messrs. Abbott, Gutmann, Stine, Pierce, Haskins, Meyers and others. Among the members present besides those just mentioned were Messrs. Rodman, Hibbard and others, and prominent among the non-members were Dr. Walter Lobach, of the German Imperial World's Fair Commission; Carl Kammeyer; Mr. Tebbett, of the Chicago office of the Westinghouse Electric Manufacturing Company; W. L. Mason, of the Mason Electric Company; W. L. Githens, manager of the Hyde Park Electric Light and Power Company, and others. Mr. B. J. Arnold was chosen chairman for the evening. At the close of the meeting a vote of thanks was tendered to Mr. Wurts for the trouble he had taken to present his lecture to the Chicago members of the Institute, and a hearty vote of thanks also given to Prof. Stine and his assistants for their kindness in placing at the disposal of the lecturer the admirable facilities which enabled him to exhibit his experimental and commercial apparatus in such a complete manner.

Moonlight Tables for July, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of July under his modified form of moonlight schedule.

TABLE NO. 1.
Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	8. 0 P. M.	2	3 30 A. M.
2	8.00 "	3	3 30 "
3	8.00 "	4	3.30 "
4	8.00 "	5	3.30 "
5	8.00 "	6	3 40 "
6	8 00 "	7	3.40 "
7	9.50 "	8	3.40 "
8	10.10 "	9	3.40 "
9	10 30 "	10	3.40 "
10	10.50 "	11	3.40 "
11	11.20 "	12	3.40 "
12	11.50 "	13	3 40 "
13			
14	12 30 A. M.	14	3.40 A. M.
15	1.20 "	15	3.40 "
16	2.10 "	16	3.40 "
17	No Light.	17	No Light.
18	"	18	"
19	8.00 P. M.	19	9.50 P. M.
20	8 00 "	20	10.10 "
21	8 00 "	21	10.30 "
22	7.50 "	22	10.50 "
23	7.50 "	23	11.10 "
24	7.50 "	24	11.40 "
25	7.50 "	25	11.55 "
26	7.50 "	27	12 30 A. M.
27	7.50 "	28	1.10 "
28	7.50 "	29	2.10 "
29	7.50 "	30	3.10 "
30	7.50 "	31	4.00 "
31	7.50 "	1	4 00 "

Total hours, 142.40

TABLE NO. 2.
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	8.00 P. M.	2	3.30 A. M.
2	8 00 "	3	3.30 "
3	8.00 "	4	3.30 "
4	8.00 "	5	3.30 "
5	8.00 "	6	3.30 "
6	8 00 "	7	3.30 "
7	8.00 "	8	3.30 "
8	8.00 "	9	3.30 "
9	8 00 "	10	3.30 "
10	8.00 "	11	3.30 "
11	8 00 "	12	3.30 "
12	8 00 "	13	3.30 "
13	8.00 "	13	12 M.
14	8.00 "	14	12 "
15	8.00 "	15	12 "
16	8 00 "	16	12 "
17	8.00 "	17	12 "
18	8.00 "	18	12 "
19	8.00 "	19	12 "
20	8 00 "	20	12 "
21	8.00 "	21	12 "
22	8 00 "	22	12 "
23	7.50 "	23	12 "
24	7.50 "	24	12 "
25	7.50 "	25	12 "
26	7.50 "	27	12.30 A. M.
27	7.50 "	28	1.10 "
28	7.50 "	29	2.10 "
29	7.50 "	30	3.10 "
30	7.50 "	31	4 00 "
31	7.50 "	1	4.00 "

Total hours, 179.50.

Note.—These schedules are made up on sun time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

An Impartial Witness.

In recent legal proceedings in London regarding the noise and vibration caused by a neighboring factory, a phonograph was used to record these noises and reproduce them in court, at the suggestion of Prof. S. P. Thompson.

The Harmonics of Alternating Currents.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

As much unnecessary mystery appears to surround the subject of harmonics in alternating currents, it may be of interest to point out the fact that the subject is in reality of great simplicity.

In music, a tone or musical note is seldom, if ever, produced perfectly pure, being almost invariably associated with a number of feebler, higher tones, whose frequencies are multiples of the fundamental or principal note. These additional tones are called overtones or harmonics, and their frequencies are 2, 3, 4, 5, 6, 7, etc., times the frequency of the fundamental. Ordinarily, the harmonics are only to be detected by the trained ear, the fundamental tone alone being heard; but, blending with the fundamental, they serve to give it that characteristic generally known as the quality of the sound.

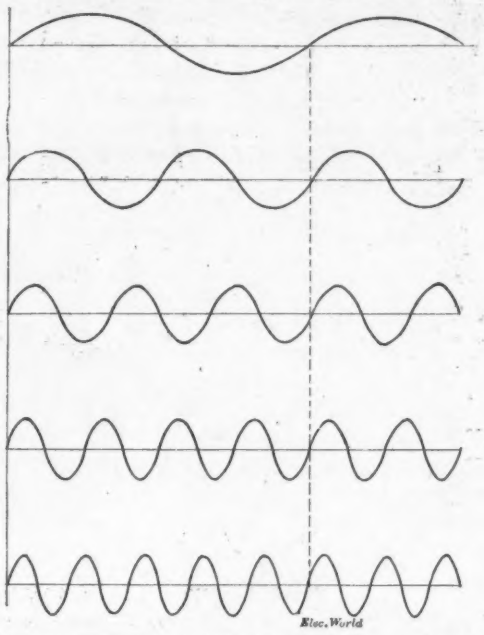


FIG. 1.—FUNDAMENTAL SINUSOID AND HARMONICS UP TO THE FIFTH, ALL WITH EQUAL AMPLITUDE.

To distinguish these harmonics, the double frequency or octave is called the second harmonic, the triple frequency, the third harmonic, and so on. A series of harmonics is represented in Fig. 1 with their amplitudes, or maximum wave heights all equal.

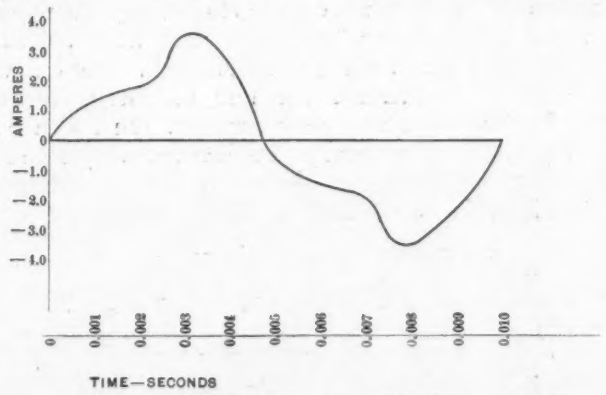


FIG. 3.—TYPE OF ALTERNATING CURRENT WAVE DISTORTED BY THE INFLUENCE OF HYSTERESIS IN MAGNETIC CIRCUIT OF TRANSFORMERS.

When a sinusoidal E. M. F. is impressed on a circuit which contains only non-ferric inductances, a true sinusoidal current is produced. Under these circumstances neither the E. M. F. nor the current will contain harmonics, but will be represented respectively by sinusoidal curves, such as shown in Fig. 2. But if the circuit contains coils embracing iron, i. e., ferric inductances; or if in any case the E. M. F. produced by the alternator is not sinusoidal, the current in the circuit will not be sinusoidal, and may be represented by some periodic curve, such as that in Fig. 3.

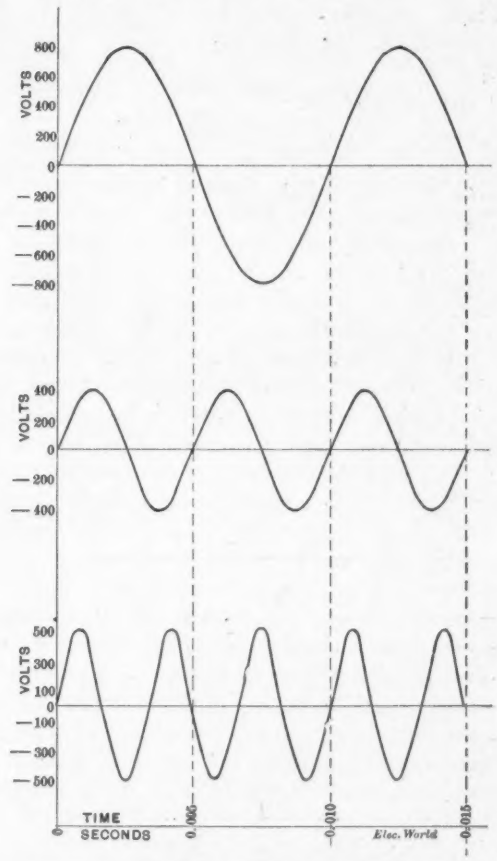
If we take an alternator that produces a pure sinusoidal wave of E. M. F., having, say, a frequency of 100 ~ and an amplitude of 800 volts, this E. M. F. may be represented as in Fig. 2.

Again, if another similar sinusoidal alternator be selected with a frequency of 200 ~ and a maximum E. M. F. of 400 volts, its curve will be represented by Fig. 4.

Now rigidly coupling these two alternators together, and connecting them in series, so that their waves cross the zero line coincidently, their E. M. Fs. are added, and the resultant E. M. F. in the circuit, obtained by summation, is shown in Fig. 5.

Similarly, taking a third sinusoidal alternator of 300 ~ and 500 volts maximum E. M. F., represented in Fig. 6, and coupling this in series with the first two alternators, so that all the E. M. Fs. start together from zero, the resulting E. M. F. is shown in Fig. 7.

Therefore, Fig. 5 represents a particular combination of a sinusoidal E. M. F. of amplitude 800 volts, with its second harmonic of amplitude 300 volts, combined in a definite phase relationship, namely, starting together from zero.



FIGS. 2, 4 AND 6.—FUNDAMENTAL SINUSOIDAL E. M. F. AND TWO HARMONIC WAVES.

Fig. 7 similarly represents another particular combination of a sinusoidal E. M. F. of amplitude 800 volts—the fundamental—and its second and third harmonics of amplitude 400 and 500 volts, respectively, in a certain phase relationship.

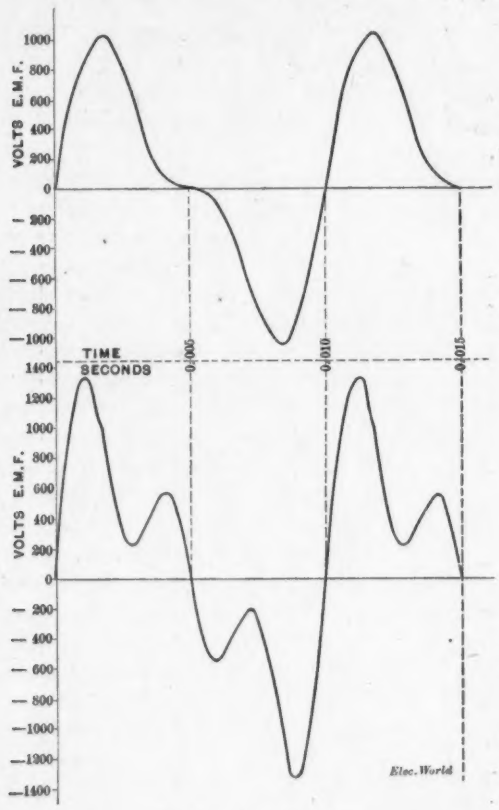
This superposition of harmonics, varying in number, amplitude and phase, might be carried to any extent, and the resulting curves might obviously give rise to great complexity.

Conversely, it can be shown that no matter how complex a curve of alternating E. M. F. appears, there must always be some combination of sinusoidal alternators, acting in series, which will produce it, and whose frequencies are in the ratios 1, 2, 3, 4, 5, 6, 7, etc., although an indefinitely large number of such alternators might happen to be needed and

their amplitudes and positions of coupling might all be different. This would correspond to resolving the complex curve into a fundamental and its series of harmonics; or, in other words, of an irregular wave into a simple wave and a series of ripple chains.

As already remarked, the current strength is not sinusoidal in an alternating current circuit supplying transformers (ferric inductances). It can be regarded, however, as a combination of a simple sinusoidal wave and some series of harmonics. Strictly speaking, in this case, the harmonics are not really present in the same sense as when a musical string is vibrating, or when a series of harmonic alternators are working together, and the conception is merely one of convenience. We merely regard them as being present in the distorted wave because the superposition of such a series of harmonics upon a plain sinusoidal fundamental wave would produce such a resultant wave.

It is evident from an inspection of Figs. 5 and 7 that in the case of a sinusoidal alternator, running in series with its

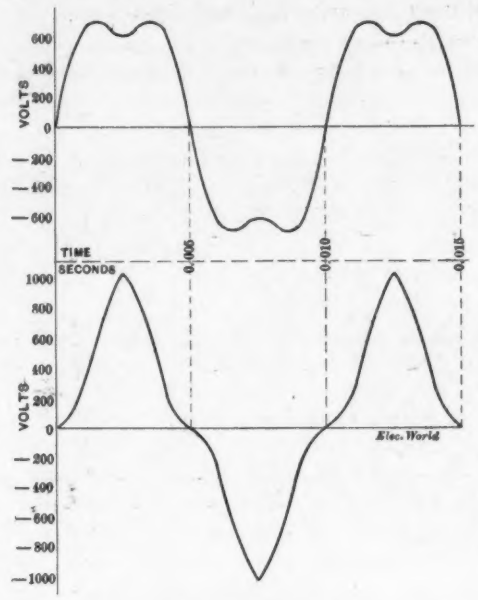


FIGS. 5 AND 7.

second harmonic, the resultant wave of E. M. F. is dis-symmetrical, that is to say, the positive wave or portion above the zero line is different from the negative wave or portion below the zero line. The former starts from the zero line abruptly; the latter slowly. The wave is also dis-symmetrical in the case of Fig. 7, where the second harmonic is also present; and it may be readily found by trial, that any superposition of the second, fourth, sixth, etc., harmonics of any amplitude or phase, i. e., even harmonics, upon a fundamental alone, or upon a fundamental mingled with its third, fifth, seventh, etc., or odd harmonics, produces a dis-symmetrical wave. But no alternator in practice does produce a dis-symmetrical wave, and, in the most complex curve of current produced from the distortion of iron, the wave must be symmetrical about the zero line, no cause being assignable for any difference in shape between positive and negative waves. This is tantamount to the statement that no even harmonics, such as the second, fourth, sixth, or fiftieth, can be expected in waves of current or E. M. F. developed in any practical alternating current circuit.

Fig. 8 shows the effect of superposing upon the fundamental wave of E. M. F. in Fig. 2 with 800 volts amplitude, its third harmonic wave, as shown in Fig. 10, with an amplitude of 200 volts, the waves starting together from the zero line in the same direction. The resultant curve is symmetrical, but very much flattened.

Similarly, Fig. 9 shows the effect of combining the same two waves with a semi-wave length of phase displacement, namely, the waves starting from the zero line coincidently in

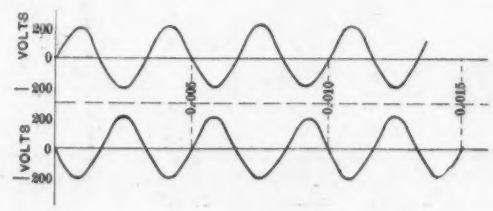


FIGS. 8 AND 9.

opposite directions, or the harmonic being displaced half a wave length, as in Fig. 11. The resultant curve is also symmetrical, but very much peaked.

Since, however, flat waves or peaked waves are the commonest deviations in form of an E. M. F. wave from the sinusoidal, Figs. 8 and 9 show that a prominent third harmonic is very common in such cases, i. e., a third harmonic of considerable amplitude is to be expected. Practically, harmonics above the fifth are not usually prominent in alternating current waves, although cases may occur in which very much higher harmonics might have a distinct influence.

Harmonics in the waves of alternating currents or E. M. Fs., or, in other words, distortions from the simple sinusoidal wave form, are objectionable in practice, when prominent. They increase the loss of energy in transformers by hysteresis and eddy currents. In motors, they tend, in addition, to generally diminish the torque and efficiency. In long insulated conductors for alternating current circuits, such as are used in the transmission of power,



FIGS. 10 AND 11.

there may exist conditions of inductance and capacity such that non-sinusoidal waves of current may be capable of producing electrical resonance by some of the theoretical or equivalent component harmonics in the distorted waves. Such waves of resonance may, either alone or in favorable combination with the fundamental, give rise to abnormal and dangerously high voltages. Thus, in Fig. 8, the combination, in opposition, of an 800-volt wave fundamental

with its third harmonic of 200 volts, produces in the resultant a maximum of about 650 volts; but in Fig. 9, the combination of the same fundamental and harmonic, with a semi-wave length of phase variation, produces a maximum resultant pressure of 1,000 volts.

For these reasons it is advisable so to design alternators that the wave of E. M. F. they deliver is nearly a pure sinusoid. Small departures from the sinusoid, i. e., the presence of small harmonics, does not usually produce deleterious consequences.

The term "higher harmonics" is really a misnomer. The word harmonic is sufficient, except, perhaps, for distinguishing upper from lower harmonics.

Discriminating Lig itning Arresters, and Recent Progress in Means for Protection Against Lightning.*

BY ALEXANDER JAY WURTS.

THE author divided his paper into three parts, the first of which described an experiment with lightning arresters on a 3,000-volt alternating current circuit at Telluride, Col. Lightning storms in those mountainous regions are of such frequency and violence that ordinary devices completely fail to give protection, and the author devoted a great deal of attention to investigating the subject and spent a number of months in Colorado testing the apparatus devised. The well-known 1,000-volt non-arcing lightning arrester, which consists of seven non-arcing metal cylinders arranged side by side with 1-64-inch spark gaps intervening, the two outside cylinders being connected to the respective sides of the circuit and the middle one to the ground, was employed in connection with choking coils. Experiments were made to determine the number of cylinders and spark gaps necessary to interrupt a short circuit on a 3,000-volt alternator with the potential raised to 3,300 volts. Nineteen cylinders were found sufficient, and three 1,000-volt non-arcing metal arresters were used, being arranged as in Fig. 1. The form of choking coil adopted after experiment was a flat coil about 18 inches in diameter and consisting of 17 turns of wire, the size of which varied with the carrying capacity of the circuit on which it was placed. After further experimenting it was decided that the trial apparatus should consist of eight choke coils and twelve 1,000-volt non-arcing metal arresters. The relative positions of these are shown in Fig. 1, which represents one end of each of three circuits.

The theory upon which this apparatus was based is that disruptive discharges form nodal points in the system. Choke coils form points of reflection where there will be a maximum tendency to discharge. A discharge spark gap should therefore be connected directly in front of a choke coil. Choke coils also offer a very high resistance to the passage of disruptive discharges. It was found desirable to connect several coils in series so that in case only a portion of a discharge should pass across the first arrester a second, third, etc., opportunity for discharge would be found. To substantiate this theory the apparatus shown in Fig. 2 was arranged, consisting of a battery of Leyden jars, *B*, choke coils, *a*, *b*, and *d*, connected into the line *L*, in series, and discharge circuits. 2, 3, 4 and 5; 1 is a 12-32-inch spark gap separating line from inside coating of the jars. This is a similar arrangement to that shown in Fig. 2. Experiments showed the difficulty the discharges had in passing the coils and the tendency they had to divide into two or more paths, part passing across the first or second gap and the rest to succeeding gaps.

The plant selected for the trial of this apparatus was that of the San Miguel Consolidated Gold Mining Company, of Telluride, Col., which is equipped with a 3,000-volt alternating current synchronous system, operating stamping mills and furnishing current to the Telluride Electric Light Company. These points are situated among the mountains at distances varying from three to ten miles from the power house. Three separate circuits leaving the power house extend over a wild and rocky country and in some places rise above timber line. The location of each bank of arresters was selected with particular reference to securing permanently damp earth for the ground plate, the lines being led to this spot. The apparatus was then installed in a specially constructed and weather-proof lightning arrester house, the arrester and choke coils being mounted on thoroughly dried wooden frames and every precaution taken to insulate these from the ground and from each other. The connections inside the arrester house are shown in Fig. 1. Great precautions were taken with the ground connections, they being made as follows: First, a hole six feet square was sunk directly under each bank of arresters until permanently damp earth was reached; second, the bottom of this hole was covered with two feet of crushed charcoal (about pea size)—crushed coke would have answered equally well; third, over this was laid 25 square feet of No. 16 copper plate; fourth, the ground wire was

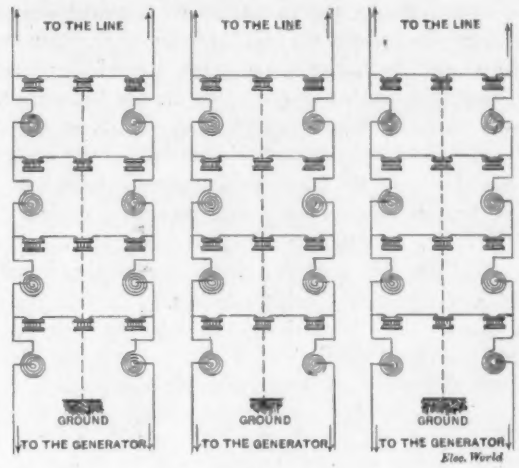


FIG. 1.

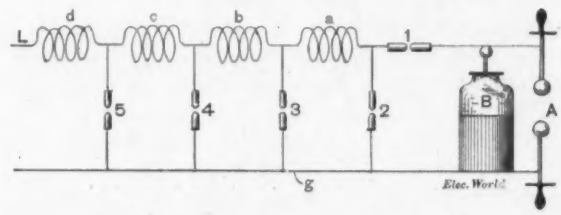


FIG. 2.

then firmly soldered all the way across the ground plate; fifth, the plate was now covered with two feet of charcoal; and, sixth, the hole then filled in with earth, using running water to settle.

Observations were taken by competent men at each bank of arresters during the entire lightning season, and the results obtained indicate that the discharges occurred most frequently over the second arresters; many passed over the third arresters; very few, however, over the first or fourth.

In Part II. a system of protection against lightning on circuits of any potential is described. The proposition is to connect in series with the circuit, and at frequent intervals, a sys-

* Abstract of a paper read at the Eleventh Annual Meeting of the American Institute of Electrical Engineers.

tem of properly constructed choke coils, the expectation being that the energy stored in the circuit in the form of static electricity will, at moments when there is a tendency to a disruptive discharge, dissipate itself in heat through the electrical surgings which will be set up between and among the several choke coils. The theory upon which this is based is more or less familiar. In many cases the lines become statically charged by the atmosphere. When a lightning discharge occurs, the potential of the atmosphere sinks to zero, and the static charge of the wire now seeks an equilibrium and in doing so sets up electrical waves which travel to the extremities of the system, are there reflected to other parts to be reflected again, etc. It is at these points of reflection that the damage is done. Circuits are probably also charged by static induction from clouds and by dynamic induction from cloud discharges. While a line is seldom, if ever, struck by direct lightning discharges, it occasionally becomes charged by some of the ramifications which accompany a lightning stroke.

If the theory of "electrical surgings" be correct, these dangerous points of reflection can, by means of choke coils, be confined to long lines and made to wear themselves out, as it were, between the coils. The number of coils which it would be necessary to use for a given length of circuit has not yet been determined, but the writer would suggest placing four to each mile of single wire. For convenient accommodation on the poles these can be arranged alternately on the two legs of the circuit, thus avoiding two coils on any one pole.

Discriminating lightning arresters are considered in Part III., the condenser lightning arrester being first taken up. The discriminating arrester must allow static electricity to pass, but must prove an effectual barrier to the dynamo current. Condensers with one side connected to line, the other to earth through a spark gap, would evidently serve this purpose. To discharge them a wet string was first used, but as a permanent leak a pencil mark over ground glass proved very satisfactory. For line or outdoor use the condenser was placed in a suitable cast-iron box, one terminal of the condenser being grounded to it while the other was led out through a specially designed and water-tight bushing. If then this iron box were buried in damp earth, as a ground plate, so to speak, the outer terminal connected to the lower electrode of a small spark gap placed on a pole, and the upper electrode of the gap connected to the line, the combination would constitute a discriminating line lightning arrester. This arrester proved itself most efficient in points of sensitiveness, durability and reliability.

A non-arcing railway arrester was, however, designed, which was smaller and more desirable than the condenser arrester. It was based on the fact that a disruptive discharge will leap over a non-conducting surface much more readily than through an equal air space. The first one constructed consisted of a pencil mark about two inches long over an unpolished piece of marble, a second piece of marble serving as a cover, with aluminium foil slipped between as terminals to the pencil mark, the whole being bound together with twine. To prevent the tendency to throw the two pieces of marble apart, a small groove was cut in the lower marble and the pencil mark made in this. As the pencil mark was gradually dissipated a piece of wood was laid in the lower marble and a groove burned in this. In the final form of the arrester the blocks were made of lignum vitae, the grooves being burned directly in the lower block. This arrester operated with uniform success.

Three Phase Installations Abroad.

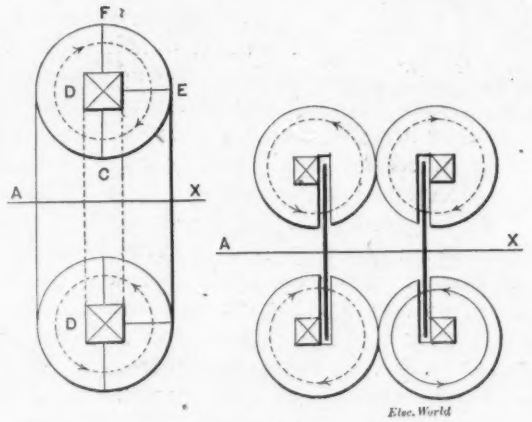
One European company has already installed 24 large three-phase dynamos, aggregating a total of 3,710 h. p., mostly for power transmission.

Unipolar Dynamos for Electric Light and Power.*

BY F. B CROCKER AND C. H. PARMLY.

DYNAMOS and motors of the unipolar type are much more practical and generally applicable than is ordinarily supposed to be the case, and the object of this paper is to bring out this fact. The term unipolar dynamo is here used in its ordinary sense to designate a machine in which electric currents are generated by the continuous cutting of lines of force. The term "non-polar" suggested by Forbes is preferable to unipolar, but it is rather meaningless and is liable to be understood to mean any kind of ironclad machine. Unipolar dynamos are also called disc or tube machines, since the armature is usually made in one or the other of these forms. Neither of these terms, however, covers the other, and they are liable to be confused with other types of machine, similar in form but different in principle. The authors suggest continuous pole dynamo as a good name for this type of generator.

It is also a common error in regard to unipolar machines to suppose that the armature cannot be made of iron. As a matter of fact, iron or steel is usually better than copper, because it is a much better conductor of magnetism and the reluctance of the magnetic circuit can be reduced far below what is possible with a copper armature, the only air gaps being the small mechanical clearances required for free rotation. A steel or wrought iron armature is much stronger than one of copper, not only on account of its greater strength for the same thickness but also because it can be made much thicker without causing any appreciable increase in the reluctance of the magnetic circuit, whereas a copper armature would have to be made very thin. The greater specific resistance of iron is not objectionable, since an armature composed of it would have a current capacity far greater than is required and the thickness can be increased to make up for the higher specific resistance.



FIGS. 1 AND 2.

The best type of magnetic circuit for unipolar dynamos is the circular ring, as shown in Fig. 1, where the axis of the magnetizing coil is coincident with the axis of the ring, the direction of the lines of force being indicated by the arrow. There are, however, but two directions in which the magnetic circuit can be cut so as to form a field suitable for practical use. One is along the radius *CD*, in which case the inductor will rotate in a plane perpendicular to the axis, and the other is along the radius *ED*, in which case the inductor will move in the convex surface of a cylinder whose axis is the axis of rotation. In the first case the armature of the resulting dynamo will be a disc, and in the second case a cylinder.

* Abstract of a paper read at the Eleventh Annual Meeting of the American Institute of Electrical Engineers.

In both, the way to collect the current would be to provide one set of collectors at the centre of the circular cross-section and the other set at the axis, thus utilizing the shaft as a portion of the electrical circuit. The relative advantages and disadvantages of the two forms depend upon circumstances in each particular instance.

In many cases the single magnetic circuit shown in Fig. 1 is not the best for practical use, because it would be necessary to make the diameter of the ring larger than it would be if two rings were placed side by side, as shown in Figs. 2 and 3, because in this type of dynamo the total magnetic induction and speed of rotation must be wholly depended on to produce the E. M. F., as it does not appear to be practicable to greatly multiply the voltage by multiplying the number of turns.

From formulas deduced in the paper it is shown that with an induction of 14 kilogausses in the field and armature, both of cast steel, the diameter of the latter to generate 10 volts at 1,200 revolutions per minute would be 24.28 inches, and for a direct connected dynamo to generate 130 volts at 200 revolutions the diameter would be 214.4 inches.

Two machines like the last one mentioned, if coupled at the ends of the shaft of a 100,000 h. p. engine would supply more current than is at present consumed in any two cities in the world. Nor is the excessive current a disadvantage, for while we would point out the tremendous capacity of one of these dynamos, there is no necessity for running them at their maximum output. Even if we

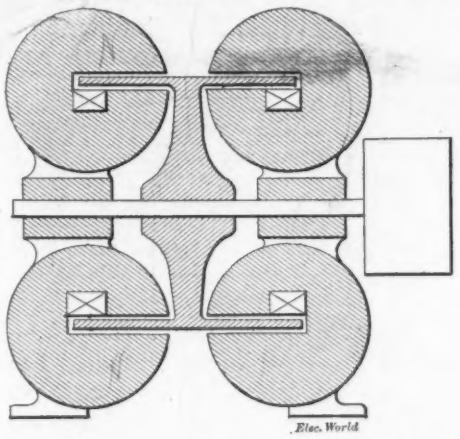


FIG. 3.

diminish the current to one-hundredth its ultimate value and only use a 1,000 h. p. engine to drive the dynamo, the loss due to the resistance of the armature will still be only

Methods of Taking Off the Current.—The best means of making electrical connection with the revolving armature is a very important but somewhat difficult matter. A great many devices have been tried or suggested. The principal of these are brushes of copper gauze or carbon, and mercury contacts applied to the edges of the disc or tube. Belts or straps made of flexible sheet copper or copper wire cable have also been used. One application of this latter device consists in connecting together two armatures by such a belt whereby the E. M. Fs. of the two machines are added together, and, if necessary, the mechanical power for driving one or both machines can be transmitted by this same belt. There would not seem to be any great difficulty in applying brushes to a unipolar dynamo; in fact, for a given current it would seem to be a much easier problem than with a direct current machine having a commutator, since the former has a continuous and smooth bearing surface for the brushes instead of the somewhat uneven surface of copper and mica which exists on a commutator. It is a fact that the speed may be very high, but with the perfectly smooth surface and by the use of brushes with light pressure and composed wholly or partly of graphite or some friction metal which might even be lubricated, it would appear to be possible to take off a current sufficient for almost any electric light or power use. If the very high speed makes the friction too great to permit of the use of brushes, the edge of the tube or disc may be arranged to run in a mercury trough, thereby making a good electrical contact with very little friction. In this case, however, provision should be made to prevent the mercury from being thrown off by centrifugal force, as by the use of a guard ring extending all round the edge of the tube or disc. Another device would consist of ball bearings applied to the shaft or to the periphery of the disc or cylinder. These might perform their ordinary mechanical function and also serve to take off the current.

An arrangement for driving which seems to possess great advantages would consist of a steam turbine running at 10,000 or 20,000 revolutions per minute, which is the ordinary speed of such machines, directly coupled to a unipolar dynamo.

Advantages of Unipolar Dynamos and Motors.—The greatest advantage of the unipolar machine is its extreme simplicity. Its armature consists of nothing but a solid cylinder or disc of steel, or other suitable metal firmly mounted upon a shaft. We have only to compare this construction with that of the ordinary armature, consisting of hundreds of pieces of sheet iron, bolted or otherwise held together to form the armature core, and wound with a great many turns of wire or bars of copper, which have to be thoroughly insulated from each other and which are not very securely held in place. In addition to this, we have the commutator, consisting of 50 or more sections of copper, separated by strips of mica and held together by nuts, etc. The electrical connections between the armature and commutator also add to the complication. In short, it would be difficult to find any two pieces of machinery in which the contrast between simplicity and complication is greater. The construction of the field magnet and the rest of the machine is also very simple. The elimination of the commutator, although already mentioned in connection with simplicity, is, nevertheless, an essential feature of this type of machine, and is a great advantage. The almost infinitesimal armature resistance of these machines is decidedly advantageous, not only in increasing efficiency and decreasing heating, but also because it causes the machine to regulate more closely either as a dynamo or as a motor. According to all accepted theories there would be no hysteresis in these machines, because both the armature and field are always magnetized in exactly the same direction and to exactly the same intensity. For similar reasons there would be no Foucault currents, since the E. M. F. generated in any element of the armature would be exactly equal to that generated in any other element, and there could be on tendency to produce eddying currents. This perfect uniformity of the magnetic field is secured by the construction, which is exactly symmetrical, the air gap being precisely the same at all points.

The question of armature reaction is somewhat doubtful, since some authorities state that it is quite considerable, but in the opinion of the authors it is very small, and certainly no greater than in other types of machine. The armature consists of only a single turn, consequently the maximum magnetizing effect of the armature in ampere turns is numerically equal to its current capacity, and since the ampere turns on the field would be made considerably greater than this, the armature reaction cannot be great. It is interesting to consider how armature reaction can occur in such a machine. The probability is that it has the effect of curving and slightly lengthening the lines of force so that they do not pass perpendicularly from one pole surface to the other in the air gap and have a spiral path in the iron, since the field current tends to produce lines in planes passing through

the axis, and the armature current acts at right angles, producing an inclined resultant. There can, of course, be no change of distribution of magnetism as a result of armature reaction, which is the really objectionable effect that it produces in the present types of machines, and in the unipolar machines there are no back ampere turns and no magnetic leakage.

In conclusion, we may say that unipolar machines are practically indestructible, since they are so simple and so strong that they are not likely to be damaged mechanically, and it is almost impossible to conceive of one being burnt out or otherwise injured electrically, since the engine would be stalled by the enormous current before the armature could be fused by it. A machine possessing all these important advantages certainly deserves a prominent place in electrical engineering, whereas it now has practically no existence whatever.

Practical Notes on Dynamo Calculation.—III.

BY ALFRED E. WIENER.

In the last section of this article, published in The Electrical World of last week, Chapter 3, on "Conductor Velocity," was accidentally omitted. It is given below. Also the headings of Tables IV. and V. were interchanged; that is, the table under the heading "Table IV.—Practical Field Densities in English Measure," should have been placed under the heading for Table V., and vice versa. Formula (5) should read as follows:

$$S = \frac{d'_a \times \pi}{12} \times \frac{N}{60}, \qquad (5)$$

In formula (6) the second equality sign was misplaced; it should be:

$$d'_a = \frac{12 \times 60}{\pi} \times \frac{S}{N} = 230 \times \frac{S}{N} \qquad (6)$$

3.—*Conductor Velocity.*

Since it is cheapest to increase the E. M. F. of a dynamo by raising its speed, it will be best economy to run a dynamo at as high a conductor velocity as practically possible. The cutting speed of an armature is limited mechanically as well as electrically; friction in the bearings, strain in the revolving parts due to centrifugal force, and heating of the armature, caused by hysteresis and eddy currents in the iron, play an important part in determining the proper conductor velocity. Furthermore, if the number of revolutions of the armature is fixed, either by its mechanical limit, or by the speed of the engine in case of a steam dynamo, or otherwise, then the above mechanical and electrical limitations alone are not sufficient for choosing the cutting speed, for too high a velocity, for instance, permissible from all other considerations, would excessively increase the diameter of the armature, and consequently would bring the size of the whole machine entirely out of proportion to its output.

TABLE III.—MEAN CONDUCTOR VELOCITIES.

Capacity in kilowatts.	Conductor velocity, in feet per second. Belt driven dynamos. Drum armatures.	Belt driven dynamos. Ring armatures.	Direct-driven dynamos
.1	25	50	..
.25	30	55	..
.5	32	60	..
1	35	65	..
2.5	40	70	25
5	45	75	26
10	50	80	28
25	50	80	30
50	50	85	32
100	50	85	35
200	50	88	40
300	50	90	42
400	..	92	44
600	..	95	45
800	..	95	45
1,000	..	95	45
1,500	..	100	45
2,000	..	100	45

In modern high speed (belt driven) dynamos the value of S, for drum armatures, varies from 25 to 50 feet per second, and for ring armatures, which offer a better ventilation and are much lighter than drum armatures of the same diameter, ranges between 50 and 100 feet per second. In slow speed (direct driven) machines, velocities from 25 to 50 feet per second are employed.

In the average values of S for various classes and sizes of dynamos are compiled.

8.—*Dimensioning of Toothed and Perforated Armatures.*

Armatures with toothed and with perforated core discs, which have been much used in recent years, offer the following advantages over smooth armatures: (1) Excellent means for driving the conductors; (2) mechanical protection of the winding, especially in cores with tangentially projecting teeth, and in perforated bodies; (3) lessening of the resistance of the magnetic circuit, and, therefore, saving in exciting power; and (4) prevention of eddy currents in the conductors. Their disadvantages are: (1) Increased cost of manufacture; (2) greater difficulty of insulating the winding from the core; (3) eddy currents set up by the teeth in the polar faces; (4) additional heat generated in the iron projections by hysteresis; and (5) leakage of lines of force through the armature core.

The latter disadvantage, however, is cancelled by the advantage of reducing, by lessening the magnetic resistance, the necessary exciting power in about the same degree as the leakage would otherwise increase it. The amount of this core leakage depends upon the relative sizes of the slots and the teeth, and, if the armature is otherwise properly dimensioned, will vary within the following limits:

TABLE XI.—CORE LEAKAGE IN TOOTHED AND PERFORATED ARMATURES.

Ratio of width of slots to their pitch on outer circumference. $\frac{n' \times s}{d''_a \times \pi}$	Factor of armature leakage. Toothed armatures. Straight teeth.	Toothed armatures. Projecting teeth.	Perforated armatures.
0.4	1.40 to 1.35	1.55 to 1.50	.....
.45	1.35 to 1.30	1.50 to 1.45	.....
.5	1.30 to 1.25	1.45 to 1.40	1.50 to 1.45
.55	1.25 to 1.20	1.40 to 1.35	1.45 to 1.40
.6	1.20 to 1.15	1.35 to 1.30	1.40 to 1.35
.65	.....	.....	1.35 to 1.30
.7	.....	.....	1.30 to 1.25

On account of this core leakage, toothed and perforated armatures are to be designed for lower field densities than smooth ones; for values of practical field densities for straight tooth armatures of various sizes see columns 4, 5, 10, and 11 of the previous Tables IV. and V., respectively, and for corresponding values for projecting tooth -, and for perforated cores, columns 5, 7, 12 and 13 of the same tables.

a.—Toothed Armatures.

The mean winding diameter, d'_a, of a toothed armature being determined by means of formula (6), its core diameter, or diameter at bottom of slots, d_a, Fig. 1, is obtained by deducting from d'_a the height of the winding space, or, in this case, the depth of the slots, h_a, averages for which are

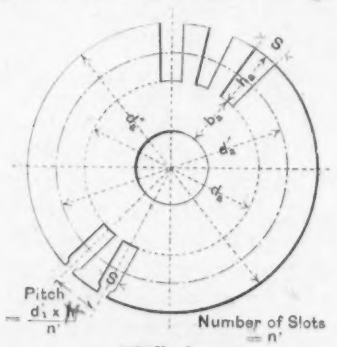


FIG. 1.

given in the fourth column of Table XV., Chapter 9. The outside diameter of the armature, d''_a, over the teeth, is obtained by adding h_a, from Table XV., to d'_a, from formula (6).

The number of the slots, n', depends upon the size of the

armature. Practice has shown that better results are obtained from deep and narrow slots than from shallow and wide ones, and, in consequence, a large number of slots is preferable to a small one. The following are good practical limits:

TABLE XII.—NUMBER OF SLOTS IN TOOTHED ARMATURES.

Diameter of armature, in inches. d''_a.	Number of slots. n'.	Diameter of armature, in inches. d''_a.	Number of slots. n'.
5	30 to 50	50	150 to 200
10	40 to 70	100	200 to 300
20	60 to 100	150	250 to 350
30	100 to 150	200	300 to 400

As to the width of the slots, its relation to that of the teeth is governed by the following considerations: On account of the disadvantage of the teeth creating eddy currents in the pole pieces, their width ought to be small compared with that of the slots; in order to reduce the hysteresis loss in the teeth, and the heat caused by the same, to a minimum, the mass of the teeth should be small, and their area perpendicular to the flow of the lines, hence their width, large; for the sake of effectively reducing the magnetic resistance of the circuit the teeth ought to be as wide as possible; and in order to prevent an excessive core leakage, finally, a small width of the teeth should be chosen. Summing up all these conditions, a good practical rule seems to be to make the width of the slots

$$s = \frac{d''_a \times \pi}{2 \times n'}, \qquad (7)$$

that is to say, to make the width of the slots equal to half their pitch on the outer circumference; for the special case of a straight tooth core, then, the width of the slots is equal to the top width of the teeth.

Applying this rule to armatures of various sizes, the writer has calculated the following table, giving dimensions of toothed armatures:

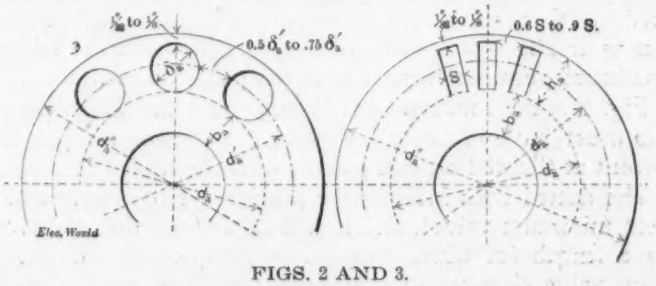
TABLE XIII.—DIMENSIONS OF TOOTHED ARMATURES.

Diameter of armature, in inches. d''_a.	Dimensions of slots. Depth, in inches. h_a.	Dimensions of slots. Width, in inches. s.	Dimensions of slots. Ratio of depth to width. $h_a : s$.	Number of slots $n' = \frac{d''_a \times \pi}{2 \times s}$	Core diameter, in inches. $d_a = d''_a - 2h_a$.	Width at bottom of tooth, in inches. $\frac{d_a \times \pi}{n'} - s$.
5	5/8	1/4	2.50	31	3¾	.125
6	¾	17/64	2.83	36	4½	.128
8	⅞	9/32	3.11	45	6¼	.156
10	1	19/64	3.37	53	8	.178
12	1⅛	5/16	3.60	60	9¾	.198
15	1¼	21/64	3.81	72	12½	.218
18	1⅜	11/32	4	82	15¾	.241
21	1½	3/8	4	88	18	.268
25	1⅝	13/32	4	97	21¾	.299
30	1¾	7/16	4	108	27½	.362
40	1⅞	15/32	4	134	36¼	.383
50	2	1/2	4	157	46	.422
60	2⅛	17/32	4	178	55¾	.454
70	2¼	9/16	4	196	65½	.487
80	2⅜	19/32	4	212	75¼	.521
90	2½	5/8	4	226	85	.557
100	2¾	11/16	4	230	94½	.602
125	3	3/4	4	262	119	.678
150	3½	7/8	4	270	143	.791
200	4	1	4	314	192	.920

b.—Perforated Armatures.

The same considerations that prevailed in determining the number and the width of the slots in toothed armatures are also decisive for the dimensioning of perforated cores. The number of perforations, for this reason, can be taken in the same limits as the number of slots for toothed cores. See Table XII.

In case of round holes, Fig. 2, the thickness of the iron



FIGS. 2 AND 3.

between two adjacent perforations should be taken between 0.5 and 0.75 times the diameter of the hole.

For rectangular holes, Fig. 3, the thickness of the iron between them is to be taken somewhat greater than for round holes, namely, from 0.6 to 0.9 times the width of the channel.

The distance of the holes from the outer periphery is to be made as small as possible, and may vary between 1-32 and 1-8 inch, according to the size of the armature.

9.—*Length of Armature Core.*

The number of wires that can be placed in one layer around the armature circumference, and the depth of the winding space determine the total number of conductors on the armature, and the latter, together with the length of active wire, gives the length of the armature core.

a.—Number of Wires per Layer.

For smooth armatures the number of wires per layer is obtained in dividing the available core circumference by the thickness of the insulated armature wire. If the whole circumference is to be filled by the winding, then

$$o = \frac{1{,}000 \times d_a \times \pi}{\delta'_a}, \qquad (8)$$

where o = number of armature wires per layer;
d_a = diameter of armature core in inches;
δ'_a = width of *insulated* armature conductor, in mils. See Chapter 10.

In case the winding is to consist in separated coils, the sum of the separating spaces is to be deducted from the armature circumference.

The value of o is to be rounded off to the nearest lower even and easily divisible number, and, in the case of a drum armature, allowance for division strips, or driving horns, is to be made according to Table XIV. This table gives the average circumferential space occupied by the division strips in drum armatures of different sizes and various voltages, in per cent. of the core circumference. After fixing the number of armature divisions, which will be shown in Chapter 11, this table may also be used to determine the thickness of the driving horns, which are usually made of hard wood or fibre, and sometimes even of iron.

TABLE XIV.—ALLOWANCE FOR DIVISION STRIPS IN DRUM ARMATURES.

Diameter of armature core, in inches.	Percentage of core circumference occupied by division strips. Up to 300 volts.	400 to 750 volts.	800 to 2,000 volts
Up to 3	12%	15%	....
" 6	10	12	15%
" 12	8	10	12
" 20	7	9	10
" 30	6	8	9

Denoting one-hundredth of these percentages by k, the core circumference being unity, the formula for the number of wires per layer in a drum armature becomes:

$$o = \frac{1{,}000 \times d_a \times \pi \times (1 - k)}{\delta'_a}. \qquad (9)$$

In toothed armatures the number of wires in one layer is found from the number, n', and the available width, s', of the slots by the equation:

$$o = 1{,}000 \times n' \times \frac{s'}{\delta'_a} \qquad (10)$$

In this formula the value of s' is to be derived from the actual width, s, of the armature slots (Chapter 8), by deducting the thickness of insulation used for lining their sides, data for the latter being given in Chapter 10.

b.—Height of Winding Space. Number of Layers.

In dividing the available height, h'_a, of the winding space by the height, δ''_a, of the insulated armature conductor, the number of layers of wire on the armature is found:

$$u = 1{,}000 \times \frac{h'_a}{\delta''_a}; \qquad (11)$$

u = number of layers of armature wire;
h'_a = available height of winding space, in inches;
δ''_a = height of *insulated* armature conductor, in mils.

The height of the insulated armature conductor, δ''_a, in the case of round or square wire, is identical with its width, δ'_a.

The available height, h'_a, of the winding space is obtained from its total height, h_a, averages for which are given in Table XV. by deducting from $^1/_{32}$ to $^3/_{16}$ inch (see Chapter 10), for the insulation of the armature core, insulation between the layers, thickness of binding wires, etc.

The nearest whole number is to be substituted for the value of u.

TABLE XV.—HEIGHT OF WINDING SPACE IN ARMATURES.

Diameter of armature, in inches.	Height of winding space, in inches. Smooth armature core. Drum armature.	Smooth armature core. Ring armature.	Toothed armature core.
Up to 2	.25	....	...
" 3	.3	....	...
" 4	.35	.20	...
" 6	.4	.225	¾
" 8	.45	.25	⅞
" 10	.5	.275	1
" 12	.55	.3	1⅛
" 15	.6	.325	1¼
" 18	.65	.35	1⅜
" 21	.7	.375	1½
" 25	.75	.4	1⅝
" 30	.8	.45	1¾
" 40	...	.5	1⅞
" 50	...	.55	2
" 60	...	.6	2⅛
" 70	...	.65	2¼
" 80	...	.7	2⅜
" 90	...	.75	2½
" 100	...	.8	2¾
" 125	...	.85	3
" 150	...	.9	3½
" 200	...	1.0	4

c.—Total Number of Armature Conductors. Length of Armature Core.

The product of the number of layers and the number of conductors per layer gives the total number of conductors on the armature; and this, divided into the total length of active armature conductor, furnishes the active length of one conductor, that is, the length of the armature body:

$$l_a = \frac{12 \times L_a}{\frac{o \times u}{p}} = \frac{12 \times p \times L_a}{o \times u}, \qquad (12)$$

where

l_a = length of armature core parallel to pole faces, in inches;

L_a = length of active armature conductor, in feet, from formula (3);

o = number of wires per layer, from formula (7), (8) or (9), respectively;

u = number of layers of armature wire, from formula (10);

p = number of wires stranded in parallel to make up one armature conductor of area $\delta_a{}^2$, formula (4);

$\frac{o \times u}{p}$ = total number of conductors on armature.

For preliminary calculations an approximate value of the number of conductors, K, all around the polefacing circumference of the armature may be obtained by dividing the conductor area found from formula (4) into the net area of the winding space. Taking .6 of the total area of the winding space as an average for its net area in smooth armatures with winding filling the entire circumference, we obtain:

$$\frac{o \times u}{p} = K = \frac{1{,}000{,}000 \times .6 \times d_a \times \pi \times h_a}{\delta_a{}^2}$$

$$= 1{,}885{,}000 \times \frac{d_a \times h_a}{\delta_a{}^2} \qquad (13)$$

This result is to be correspondingly reduced for windings filling only part of circumference, or to be multiplied by $(1 - k)$, see formula (9), in case of a drum armature, respectively.

In toothed armatures the average net height of the winding space is about three-fourths of the total depth of the slot, hence the approximate number of armature conductors:

$$\frac{o \times u}{p} = K = \frac{1{,}000{,}000 \times n' \times s' \times {}^3/_4\, h_a}{\delta_a{}^2}$$

$$= 750{,}000 \times \frac{n' \times s' \times h_a}{\delta_a{}^2} \qquad (14)$$

In (13) and (14) the values of d_a, h_a and s' are given in inches, and $\delta_a{}^2$ in circular mils.

(To be continued.)

The Practical Importance of Resonance in the Transmission of Electrical Power.—IV.

BY F. W. DUNBAR.

Up to this point we have considered the problems of tuning the circuit by means of varying both the capacity and inductance, but if for any reason it is impossible or inadvisable to change but one of the constants, the circuit may still be more or less perfectly tuned by varying the other constant, just as it is possible to tune more or less perfectly any string to a certain pitch by altering either its tension or weight alone. We have shown that if $L\,\omega > 5\,\pi\,R$ then the circuit may be perfectly tuned by altering either C or L alone, but if $L\,\omega$ is less than $5\,\pi\,R$, then the circuit can be only imperfectly tuned, just as it is impossible to make a very light string respond perfectly to a low pitched tone. Its tension must be so little that the wave impulses quickly die out—are absorbed by the string and their energy dissipated in the form of heat instead of being stored up as potential energy and given out to the immediately succeeding impulse. Just so when our line wires are built with their electrical inertia (L) small with respect to their resistance—the almost invariable practice at present—it is impossible to make them respond to low pitched tones and a large part of the energy which is pumped into them, instead of being transmitted, is simply absorbed and dissipated as heat.

We shall, however, discuss the cases of partial resonance secured by varying either one alone of the constants C and L, the other being maintained constant. The equations for these two cases we have already deduced.

Thus for C constant L varying we have

$$\frac{L\,\omega}{(K^2 + L^2\,\omega^2)^{1/2}} = \frac{a\,l}{2} \left\{ \frac{\sinh\left(\frac{a\,l}{\tan\,\mu}\right)}{\frac{}{\tan\,\mu}} - \sin a\,l \right\} \Bigg/ \left\{ \cosh\left(\frac{a\,l}{\tan\,\mu}\right) - \cos a\,l \right\} \qquad (12)$$

and for L varying C constant we have

$$\frac{a\,l}{2} = \frac{\cosh\left(\frac{a\,l}{\tan\,\mu}\right) - \cos a}{\frac{\sinh\left(\frac{a\,l}{\tan\,\mu}\right)}{\tan\,\mu} + \sin a\,l} \qquad (13)$$

The solutions of these two equations are evidently similar in form, and are continuous valued functions, varying through infinity an infinite number of times, and include both the values which will render I a maximum and which will render I a minimum.

Fig. 5 gives the solution of equation (13), where L varies and C remains constant; that is, if C has any definite fixed value, whatever it may be, the ordinate of this value of $C\,\omega$ as an abscissa is the values of $L\,\omega$ which will yield the maximum possible current with *this* particular value of $C\,\omega$.

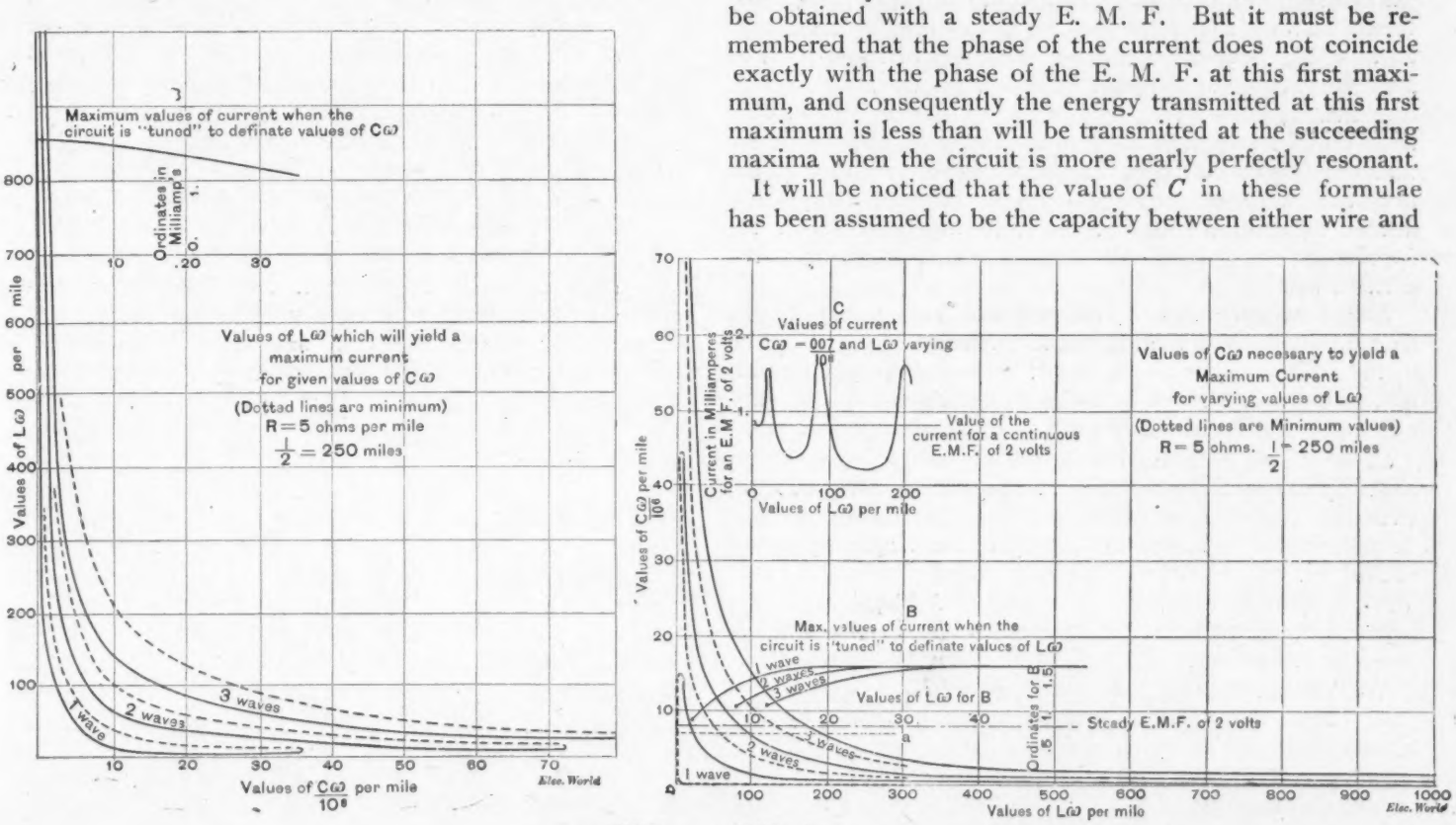
Fig. 6 is the solution of (12), and gives the values which $C\,\omega$ must have in order to yield the maximum possible current at the distant end for any definite values of $L\,\omega$.

The dotted lines indicate the portions of the curve which yield minimum values, and it will be noticed that for every wave length (of which only three are plotted), the maximum value changes to a minimum value at some definite values of $L\,\omega$ and $C\,\omega$, then continues back to infinity, where it again changes to a maximum value as the wave lengths increase from n to $n + 1$.

It will also be noticed that the values of $C\ \omega$ for a given value of $L\ \omega$ are less in Fig. 6 than in Fig. 5, but that above the values of 80 ($5\ \pi\ R$) for one wave, 160 ($10\ \pi\ R$) for two waves and 240 ($15\ \pi\ R$) for three waves, the curves of maximum $C\ \omega$ and maximum $L\ \omega$ coincide, and this method of solving equation (14) might have been adopted but for its laboriousness. For the coincidence of these two curves gives those values which mutually satisfy equations (12) and (13), that is, which satisfy equation (14). This, then, again gives the result that $L\ \omega$ must exceed $5\ \pi\ R\ n$.

At B in Fig. 6 is shown the maximum values which the current can attain by tuning the circuit as perfectly as possible (by adjusting the capacity) for values of $L\ \omega$, including those values where $L\ \omega$ does not exceed $5\ \pi\ R\ n$. The ordinates are in milliamperes and the total maximum voltage is 2; i. e., 1 volt on each side. The maximum values for one, two and three waves are shown.

It will be noticed that it requires a smaller value of $L\ \omega$ to make the circuit perfectly resonant when there is but one wave length in the circuit than when there are two or more.


Maximum values of current when the circuit is "tuned" to definate values of Cω
Ordinates in Milliamps
Values of Lω which will yield a maximum current for given values of Cω
(Dotted lines are minimum)
R = 5 ohms per mile
1/2 = 250 miles
1 wave
2 waves
3 waves
Values of Lω per mile
Values of Cω / 10⁶ per mile
Elec. World
C
Values of current Cω = .007 and Lω varying
Value of the current for a continuous E.M.F. of 2 volts
Current in Milliamperes for an E.M.F. of 2 volts
Values of Cω necessary to yield a Maximum Current for varying values of Lω
(Dotted lines are Minimum values)
R = 5 ohms. 1/2 = 250 miles
B
Max. values of current when the circuit is "tuned" to definate values of Lω
Values of Lω for B
Ordinates for B
Steady E.M.F. of 2 volts
a

FIGS. 5 AND 6.

This, of course, is directly expressed in the equation $L\ \omega = 5\ \pi\ R\ n$.

It will also be noticed that the values of the maximum current seem to indicate a perfect resonance before $L\ \omega = 5\ \pi\ R\ n$. Thus with one wave the maximum value of the current seems to be reached at about $L\ \omega = 30 = 2\ \pi\ R$, but the plot is somewhat misleading, as it does not include the phase of the current. Thus, it would appear possible to transmit a greater amount of power with an alternating current upon this circuit when $L\ \omega$ has a value of but 2.2 or less than $1/2\ R$ than with a direct current, for the plot indicates that a greater current at the distant end will result if the circuit is tuned as perfectly as possible with this value of $L\ \omega$ than would result with a continuous or steady voltage of equal magnitude. But while the current would be greater were there no receiving instruments at the distant end of the line, yet the power would be much less, as the phase of the E. M. F. would not coincide with the phase of the current for the maximum value of the current at this point. The plot indicates clearly, however, the necessity for increasing the inertia (inductance) of the circuit up to or above a certain value before the complete advantages of resonance can be secured.

Diagram C in Fig. 6 represents the values of the current which will result at the distant end of this circuit, 250 miles in wire length, and of 5 ohms resistance per mile, if the capacity be maintained constant at one-half the value it would naturally have with a separation of the wires of about 12 inches; that is, a mutual capacity of about .00375 microfarads per mile, and if the value of $L\ \omega$ be increased from 0 up to 200 or more, ω being maintained constant at 1,000, corresponding to a frequency of about 160 $\sim$ per second.

Thus C may be described as a section of the main plot in Fig. 6, taken through the dotted line a, which corresponds to a value of $C = .007$ microfarad. It will be noticed that at the first maximum, which occurs at $L\ \omega = 22$ ($1.4\ \pi\ R$), the current does not reach as high a value as is reached when there are two or more wave lengths in the circuit, but yet it is far in excess of the value which could be obtained with a steady E. M. F. But it must be remembered that the phase of the current does not coincide exactly with the phase of the E. M. F. at this first maximum, and consequently the energy transmitted at this first maximum is less than will be transmitted at the succeeding maxima when the circuit is more nearly perfectly resonant.

It will be noticed that the value of C in these formulae has been assumed to be the capacity between either wire and a ground half way between the direct and return conductors; that is, just twice the *mutual* capacity of the two wires and approximately the value of the capacity of either wire alone to ground as measured in ordinary cases in either line or cable conductors.

At the time of constructing Fig. 3 this distinction was not perceived, and consequently instead of Fig 3 representing the case of a line with the capacity which it would naturally have, as was intended, it represents a case where the capacity is but one-half as great. However, the actual numerical value of the capacity is immaterial to the question, and Fig. 3 truly represents the case of partial and complete resonance on a circuit having a mutual capacity of .0037 microfarad per mile. To Mr. Kennelly is due the credit of pointing out the fact that the factor C represents twice the mutual capacity.*

(To be continued.)

* See The Electrical World, Feb. 17, 1894.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING

ELEC. WORLD, N.Y.

ELECTRO-PHYSICS.

New Experiments with Vacuum Tubes.—The results of some new experiments of Sir David Salomons are briefly summarized in the Lond. "Elec. Rev.," May 4; among other things he finds that the bands are not formed in large open tubes as they are in small ones; the effect of short rods, as also contractions in screens, placed in the tubes, are given; the sticking effect of the bands to the glass is shown very clearly with spheres; by altering the current it may be shown that the bright and dark bands are illusory, and that the bright bands really overlap, the overlappings appearing double as bright, and that therefore the positions of the apparently bright bands are really the true positions of the dark bands.

Electromagnetic Synchronization.—A long paper by Mr. Cornu, chiefly of a mathematical character, is given in full in the "Bul. Soc. Int." for April; he discusses synchronization in general, mechanical as well as electrical, as also various applications of the theory.

Curve of Magnets and Transformers.—A Physical Society paper by Major Hippesley on "A Graphical Method of Constructing the Curves of Current in Electromagnets and Transformers" is abstracted briefly in the English journals of May 11.

Mechanism of Electrical Conduction.—A Physical Society paper of Mr. Burton is abstracted briefly in the English journals of May 11.

New Views Regarding the Nature of the Electric Current.—The "Elec. Anz.," April 29, contains an article by Mr. Schwartze on this subject.

MAGNETISM.

Magnetic Qualities of Iron.—The paper of Prof. Ewing and Miss Klaassen is concluded in the Lond. "Elec.," May 11. A striking example of the influence of molecular shaking is described; two independent magnetizing coils were used, in one of which the current was rapidly reversed, and it was found that the magnetizing effect of a steady current then became almost wholly independent of the previous magnetic history, or, in other words, the effects of hysteresis nearly disappeared; this method of agitating the metal obliterated hysteresis more completely than mechanical vibration. The next experiments showed the effects of time lag, which was most apparent in the softest iron, especially when solid or poorly laminated; even for low frequencies, such as three seconds and 0.43 seconds per cycle, the hysteresis curve grew shorter and wider, had rounded corners and a nearly elliptical shape; curves for these are given; the time lag thus lowered the maximum of magnetization enormously; it also increased the work spent in magnetic reversals appreciably, it being remarkable how great this influence is at very moderate speeds of reversal; the area of the curve increased at first and then decreased as the frequency is increased, thus showing a maximum for some one frequency, which they say is due to the effect that the magnetization fails to penetrate sufficiently into the interior at higher frequencies; in steel these phenomena are much less apparent than in soft iron; it is not easy to say whether this time lag is due entirely to Foucault currents and suggestions are made for a test to determine this; it is suggested that the greater the amount of surface the mass of iron presents, the more quickly it is likely to take up the full amount of magnetic induction; the tests show that the ordinary ballistic tests are liable to serious error when the specimen tested is a solid bar of any considerable section, especially when the material is soft iron, unless the ballistic galvanometer has a much longer period than is usual. In conclusion, they describe some interesting experiments with groups of pivoted magnets, relating to the molecular theory and showing similarity in their behavior as compared with masses of iron.

Magnetic Property of a Static Discharge.—The "Elek. Zeit.," April 26, contains an article by Mr. Zielinske, in which he first reviews briefly the various publications on this subject, giving the references and descriptions of some observations of his own in connection with a test of lightning arresters for telegraph lines, showing among other things that the explanation of Waltenhofen of the appearance of reversed magnetism, due to a discharge, is correct; he discusses the practical application of these principles, showing among other things that the magnetic properties of a lightning discharge will not manifest themselves in the deflection of neighboring magnets; a lightning indicator should, under all circumstances, remain inactive, even to great electric currents, but should in all cases indicate a lightning discharge. He describes an ingenious lightning indicator based on these principles, consisting of a compass box attached to the lightning rod and containing a magnet in the form of a 12 pointed star with long, narrow points, magnetized so that it forms the equivalent of six or less magnets crossed through the centre; one of these is marked and there is a corresponding mark on the movable glass cover; the compass is so fastened that a current in the lightning rod would produce a deflection; it is set by having the two marks correspond; if a discharge passes through the lightning rod the magnetism in the star will be shifted, and it will afterwards be found to be differently magnetized, so that it will take a different position, which will be seen by the different relative positions of the marks; each succeeding discharge will shift it again; it was found that 0.003 coulomb is sufficient to cause this shifting, and it is therefore sufficiently sensitive, even for slight discharges, as Kohlrausch has shown that the quantity of electricity in an atmospheric discharge varies between 52 and 270 coulombs.

Hollow and Solid Cores.—In a paper by Mr. Du Bois, abstracted in the "Phil. Mag." for May, he says there is no

need for assuming that the central fibres of cores are less easily reached by temporary steady magnetization than those near the surface; such a state of things would be proved only if the same result is obtained with hollow endless rings, which is improbable. "If for cylindrical or prismatic bodies of given length and any shape of section the 'demagnetizing factor' be proportional to the latter and not too small, then the magnetic moment will be practically independent of the section for fields which are so strong as to produce an approach towards saturation."

Winding Alternate Current Magnets.—A Physical Society paper by S. P. Thompson and Mr. Walker is abstracted briefly in the English journals of May 11. When the magnetic induction does not exceed 4,000 C. G. S. units (4 kilogausses), the pull of a laminated magnet on its armature is the same whether caused by a continuous or an alternating current of equal strength, but for higher inductions the force is slightly greater for the continuous current. In alternate current magnets wound for a given excitation and for a constant voltage, they showed that the ampere turns are inversely proportional to the number of turns, as the impedance varies nearly as the square of the number of turns; such magnets have a fairly constant pull over a long range, as the current increases when the armature moves away from the magnet; the alternating voltage required for a given force is much greater than for continuous currents; with the armature in contact the ratio of the two voltages was 170, and when separated for a distance of 9.2 millimetres the ratio was 21.5. In the discussion Mr. Blakesley thought it better to fill the space of a magnetic coil full of copper rather than use a wire only just large enough to carry the current; Mr. Swinburne suggested using a condenser calculated for the same current, in connection with alternate current magnets, but other speakers thought the capacity would be impracticably large.

Alternating Currents and Hysteresis.—In the article under this heading in the Lond. "Elec. Rev.," May 11, Mr. Whitwell states that the ellipse could be used as a curve whose equation is well known and which approximates to the hysteresis curve, suggesting that some useful result might thus be obtained; he discusses the relations mathematically.

Standards of Magnetic Fields.—A paper by Mr. Du Bois is abstracted in "La Lum. Elec.," May 5, in which he discusses the use of different kinds of glass as standards for magnetic fields, based on the phenomena of polarization; a plate 1 millimetre thick is used for a field of 1,000 C. G. S. units (1 kilogauss).

Magnetic Properties at Different Temperatures.—"Comptes Rendus," volume CXVIII., No. 15, contains a paper by Mr. Curie, describing his series of researches made between 20 and 1,375 degrees C. and between 25 and 1,300 units of density.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measurement of Inductance.—The Lond. "Elec.," May 11, calls attention to a paper by Mr. Abraham in the "Jour. de Phys." for April, in which he describes a method for measuring inductance accurately within one part in a thousand; it consists in "balancing a steady current passing through one pair of coils of a differential galvanometer against a succession of induced currents sent, by means of a commutator rotating at a known speed, through the coils; the commutator then being stopped, the secondary circuit, containing one pair of coils of the galvanometer, is connected with the extremities of a resistance, r, in the primary circuit; the value of r, is altered till the galvanometer is undeflected, then from a knowledge of the value of r, and the speed of rotation of the commutator, the value of the mutual induction can be calculated.

Standard of Light.—The "Bul. Soc. Int." for April abstracts a paper read before the Berlin Academy of Sciences by Messrs. Lummer and Kurlbaum, based on experiments made at the Imperial Technical Institute. A strip of platinum is heated by an electric current to a high temperature, the temperature being measured and adjusted by the radiation from the surface; this is measured by a bolometer, first directly and then after the rays have passed through a layer of water of 2 centimetres thickness; the desired temperature is attained when the ratio of these two radiations is as 10 to 1; the light emitted by one square centimetre of platinum is then taken as the standard; a brief description of the apparatus is given, and it appears that the measurements are of a delicate character. A somewhat more complete description is given in "La Nature," May 5.

Frequency and Phase Indicator.—According to the French journals, Mr. Janet described before the Academy a simple graphical method, based on the record left by the current in passing through a band of paper saturated with ferro-cyanide of potassium, as in the Bain electro-chemical telegraph.

Absolute Electrometer.—The Guglielmo electrometer, based on the application of a manometer, to measure the electrostatic pressure, is described and illustrated in "La Lum. Elec.," May 5.

Conductivity of Pure Water.—According to a paper in the "Phil. Mag." for April, the calculated electrical conductivity of pure water at 25 degrees (C. degrees?) is 0.56×10^{-11}.

Acidity Meter.—The Colette meter is described in "La Lum. Elec.," May 5; it consists simply of a plate of zinc and one of copper, secured in a support and placed in the liquid whose degree of acidity is to be measured, the couple being connected to a galvanometer; it is said to have been used with success in a number of sugar factories.

ARC AND INCANDESCENT LIGHTS.

Incandescent Lamp Manufacture.—In the continuation of Mr. Bainville's article in "L'Elec.," April 28, he discusses the subject of the filament and its manufacture; a translation of this series of articles is being given in abstract in the Lond. "Elec. Rev."

Lamp Pendant.—A new form of flexible pendant is described in the Lond. "Elec. Rev.," May 11; it consists of telescopic tubes secured at the top by a spherical joint, the wires passing through it in the form of a loose coil.

Searchlights for Canals.—The portable plant used in the Manchester Canal is described and illustrated in the Lond. "Elec. Eng.," May 4; it is similar to that which has been in use in the Suez Canal for over a year; the searchlight is mounted on a portable cage, which may readily be placed on the vessel.

Cored Carbon Litigation.—A communication on this subject is contained in the "Elek. Zeit.," May 3.

TRANSMISSION OF POWER.

Long Distance, High Tension Transmission.—In the "Elek. Zeit.," May 10, Dr. Behn-Eschenburg describes an experiment made at the Oerlikon Works of transmitting power by means of a simple alternating current to a distance of 27.6 miles at 33,000 volts and accompanies the same by a comparatively simple analytical discussion of the various factors which enter, showing that the various factors can be calculated qualitatively and approximately quantitatively by comparatively simple computations based on data determined by the constructor; the agreement of the calculated and observed results is shown to be sufficiently close for practical purposes, even when the hysteresis effect is only estimated. The transmission took place over four overhead wires leading from the factory to a neighboring town and back, thus enabling all the tests to be made at the factory; the line was supported by 920 oil insulators about 30 feet above the earth, and was 4 millimetres (about a No. 6 B. & S. wire) in diameter, the line being the one in use regularly for transmitting the water power from Beulach to the factory by means of a three-phase current; a 50-h. p. alternator of 2,000 volts was used, the current being transformed

up to 33,000 for the line, thence down to 2,000 volts, and was consumed in inductionless resistances, after having been again transformed to 200; the measurements were made in both the 2,000-volt circuits. The loss in the line was only 1,000 watts, representing a current of 0.03 ampere, or an insulation resistance of 3 megohms, and it appears that a direct measurement gave the same insulation resistance; other interesting deductions are made, but they do not admit of being abstracted, as they depend on the specific conditions. In conclusion, he states that as the current at no load exceeds the capacity of the dynamo and transformer, an installation at such high voltages should be used only with large loads in order to be efficient.

Electric Motive Power.—A paper by Mr. Selby-Bigge, read at the recent meeting of the Iron and Steel Institute on "Electricity as a Motive Power in the Iron and Steel Industries," is abstracted in the Lond. "Elec. Eng.," May 11. He discusses the application to mining and the utilization of heat from blast furnaces, the greater part of the paper being devoted to short distance transmission and concentration of power; a table of tests is given, in which the power required by various machines used in the iron industry is given, when driven by a steam engine and when this is replaced by an electric motor, the tests having been made at the works of a large company; the saving of coal effected on these tools amounted to 30 tons per week, after the adoption of the electric motors. Another table is given, in which the results are calculated, comparing the efficiencies for varying loads, both for electrical and mechanical transmission; at full load they are equivalent, but become very different as the load diminishes; with one-fifth of a load the electrical transmission still yields 47.2 per cent., while the mechanical transmission, with shafting, etc., had all its power absorbed in the constant frictional loss of 206 h. p., the original power being taken as 1,000; the author is greatly in favor of electrical transmission for short distances and the consequent concentration of power.

ELECTRIC RAILWAYS.

Electric Traction in England and Germany.—In a comparison made by Mr. Paisley in Lond. "Lightning," May 3, he gives an itemized table of the roads in the two countries, showing that in Germany there were in March, 1894, 130 miles of single track, while in England there were only 71 miles, and that in Germany the mileage was increasing rapidly, one company alone having contracts for no less than 100 miles; but while most of the lines in Germany are simple overhead lines, some of those in England are of a much more expensive character, the total capital involved in the English lines being almost ten times as much as in Germany.

Electric Traction in Tunnels and on Mountain Roads.—The advantages of electric traction are pointed out briefly by Mr. Lea in the Lond. "Elec. Eng.," May 4; in comparing rack roads with adhesion systems, he states that the ratio of tractive force to engine weight in adhesion systems can rarely be allowed to exceed one in five, it being usually less; with a rack, however, the ratio is nearly reversed, as the engine weight need only be about one-quarter of the tractive force to overcome the tendency of the rack pinions to climb out of gear.

Suspended Railway in Vienna.—One of the proposals for a road in Vienna was an overhead line with suspended cars at a sufficient height not to interfere with traffic on the streets.

Conduit Road at Blackpool—In an article on electric traction in England, by Mr. Wilkinson in the Lond. "Elec. Plant" for May, he states that the Blackpool line, which has been running for over eight years more or less unsatisfactorily, has now completely broken down, and that it was, until bought by a corporation, in 1892, earning a handsome dividend on a capital of about $77,000 per mile.

Series Conduit System.—"Cosmos," May 5, contains an illustrated description of the system of Captain Cattori, installed in the city of Borghese; cars are connected in series and the current is taken from an inverted rail suspended in a conduit near one of the tracks, the slot being only one-half inch wide.

Novel Overhead System.—The "Elek. Echo," May 12, describes the system mentioned in the Digest May 19, giving in addition several illustrations; it is concluded in that article that this system is entirely impractical.

Accumulator Traction.—Mr. Walker, in the Lond. "Elec. Rev.," May 11, makes the statement that it is impossible to place sufficient accumulators on a fully loaded car to enable it to start on a wet day if the gradient is over one in twenty.

Accumulator Road in Paris.—"L'Elec.," May 5, contains a well illustrated article, giving a rather complete description of this road, together with data and a profile; a translation is given in abstract in the Lond. "Elec. Eng.," May 11.

Electric Vehicles.—In the continuation of the article on electric traction on common roads, "Industries and Iron," May 11, gives an illustrated description of an electric omnibus and a carriage.

Mountain Railway.—A short description of the Stanserhorn railway in Switzerland is given in the Lond. "Elec. Eng.," May 11.

Oil Engines for Railways.—In the "Lond. Elec. Rev.," May 11, Mr. Walker discusses the probability of the Connelly motor becoming a serious rival of electricity for traction purposes, and expresses his opinion that it will not; this motor consists of a pair of oil engines developing about 12 brake horse power, an oil tank being carried on the car, the oil being heated by the cooling of the water; a variable speed friction gearing is used, which is an essential feature and which Mr. Walker believes will fail.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Station Statistics.—An interesting table of statistics, compiled by Mr. Uppenborn for the leading German electrical society, is published in the "Elek. Zeit.," May 3, together with an analysis of it; the table gives quite completely certain data for a number of the stations in Germany and a few in other countries on the Continent; they are divided into groups according to the population of the cities; the table gives almost exclusively an analysis of the output of the station, including a percentage distribution between certain classes of consumers, certain comparative data, such as the output per thousand inhabitants, per metre of house frontage, the consumption per thousand inhabitants, the maximum consumption, and the relation of this maximum to the installed capacity; under the latter heading the relation is 46.4 per cent. in Berlin, in Vienna 60.2 per cent. the highest being 87.3 per cent. in the small town of Innsbruck, the general average being perhaps about 50 per cent. or a little over, the figures varying considerably. In the analysis he states that no returns were obtained from quite a number of important stations and that the table is therefore by no means complete; by far the larger number of stations use the continuous current; in the city of Elberfeld the average yearly efficiency from the poles of the dynamos to the meters of the consumers is nearly 99 per cent., which is a remarkable case, but it is explained by the fact that the losses in the lines are exceedingly small, and that in the day time so little current is used that the loss is practically nothing. Although not complete, the table is of considerable interest to central station designers.

Automatic Fault Indicators.—In a paper by Dr. Passavant, in the "Elek. Zeit.," April 19, he describes briefly the automatic indicators used in the Berlin station, showing how reliable they have been, and adding that their introduction

in stations should now be considered a necessity. The descriptions of these devices have already been referred to in the Digest; they are briefly as follows: The test wires of the outer wires of a three-wire system are used to indicate the faults; the test wires of the distributing mains are connected radially with those of the feeders but with opposite polarity to that of the core of the cable; in the junction boxes fuse wires are inserted and in the central stations a relay; if a short circuit occurs in a cable between the test wire and the core, the fuse will blow and the relay will indicate the district. In the second system, that of Dr. Kallmann, the difference of potential of the earth caused by a fault is used; the test wires of the neutral wire of the distributing mains are grounded as often as possible and in the junction boxes are connected with the corresponding neutral wire, which at the central station is connected to earth through relays, which localize the grounds. He states that it is not the faults occurring in the interior of the cables that are to be feared as much as those produced from exterior injury.

Switch for Self-Induction Circuits.—A simple and inexpensive system is described in the "Elek. Zeit.," April 19, for avoiding the sparking in opening a circuit, such as that of the field winding of a dynamo, in which there is great self-induction; an inductionless resistance which is short circuited under normal conditions is first put in circuit, the part containing the self-induction is then short circuited, after which the circuit is opened; the switch may be so constructed that these operations may be performed by one movement of the switch handle.

Cost of Electrical Energy.—The cuts of Mr. Crompton's recent paper, as also the discussion, are given in the Lond. "Elec. Eng.," May 11; the discussion is published in this journal and in the Lond. "Elec. Rev.," and is confined exclusively to the mechanical engineering features. In the latter journal Mr. Booth discusses some statements in this paper, more particularly those concerning the North of England coal.

Erding.—The small central station on the three-phase system, in this town, is briefly described in the Lond. "Elec. Eng.," May 11.

Paris Sub-Stations.—A translation of the article by Mr. Laffargue, mentioned in the Digest May 19, is given in the Lond. "Elec. Rev.," May 11.

WIRES, WIRING AND CONDUITS.

Heating of Wires.—A rather complete theoretical discussion by Mr. Colard is contained in "La Lum. Elec.," May 5; in it he deduces laws based on absolute temperatures, in which he assumes that the specific resistance of a pure metal is proportional to the absolute temperature.

Cables.—In a Dewers cable, illustrated in "La Lum. Elec.," May 5, powdered chalk is introduced at intervals between the wires and the lead casing, the object being to absorb the last traces of moisture in the cable and to keep it dry.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Multiple Telephony.—A paper entitled "A Revolution in Telephony," by Mr. Nissl, is abstracted in the "Zeit. fuer Elek.," May 1, describing a system, in which a number of subscribers have separate lines to a nearby centre, from which centre there is only one connection to the central station, and in which each subscriber can connect himself with the station independently of the others; a clockwork at this common point drives a contact drum, connecting each subscriber in turn with the station, say, once a minute, and notifying the subscriber of the exact time of connection by a sound in the telephone; at the moment of contact the subscriber can stop the revolution of the drum and be in communication for a limited time, say, about five minutes; during this conversation it is not possible for any others to interrupt; a signal is automatically given one-quarter of a minute before the five minutes are up; it is stated that three wires are necessary for each subscriber, as well as from the common point to the station, and an additional wire in case earth connection is not used (the latter feature would seem to more than balance the advantages gained).

Safety Fuses for Telegraph and Telephone Purposes.—In the "Elek. Zeit.," May 10, Mr. Uppenborn mentions that he has made experiments with fine fuses in vacuum tubes, the idea of the vacuum being to prevent the loss of heat and therefore to produce fusion with less current; manganin wire and tinfoil were used; in vacuum they fused at between 0.17 and 0.2 amperes, while without a vacuum the ranges were from 0.19 to 0.23; greater constancy could be obtained by greater care in their manufacture. In the discussion, Dr. Strecker states that the Morse apparatus will stand at most 0.25 to 0.3 ampere continuously and telephones 0.15 ampere; he gives a table of the fusing and exploding point of wires of various metals; Mr. Uppenborn believes that these fuses can be made for as low as 0.10 to 0.13 ampere.

Legal.—The case of Muirhead vs. The Commercial Cable Co. in London, regarding the "Duplex" patent, has been decided in favor of Muirhead; the English journals of May 4 contain the reports and comments. Some of the points in this litigation are discussed by Mr. Dykes in the Lond. "Elec. Rev.," May 11.

Telephone Annunciator.—The automatic annunciator used with Paris telephones, as also those of Hall and Pickernell, are illustrated and described in "La Lum. Elec.," May 5.

Time Distribution.—In the "Elek. Zeit.," May 3, Mr. Kohlfuerst gives a well illustrated description of the automatic time distributing clock of the Government railways at Berlin.

Water Level Indicator.—"La Lum. Elec.," April 28, abstracts from "Engineering," Feb. 2, a description of a device made in England.

Telegraph Pole.—A new device for that part of the pole which is in the earth is illustrated in "La Lum. Elec.," April 28.

ELECTRO-CHEMISTRY.

Electrolysis of Fused Salts.—In a paper by Mr. Vautin, abstracted in the Lond. "Elec.," May 11, he describes a process in which the cathode is made of some heavy metal, such as lead for the electrolysis of sodium chloride, and tin for potassium chloride; the metal whose chloride is electrolyzed appears in the form of an alloy of these heavy metals; this alloy is then treated with water or steam to produce caustic soda or potash. Advantages are claimed over the wet method, such as avoiding the necessity of evaporation, the absence of a diaphragm and the low resistance of the electrolyte; the efficiency claimed, as deduced from recent experiments, is given as 80 per cent., but no estimate of the manufacturing cost has yet been given; a plant is soon to be started; a high current density, up to several hundred amperes per square foot, can be adopted; the minimum voltage is slightly less than two volts. In a discussion the advocates of the wet process claimed an efficiency of 85 per cent. and stated that the salt would cost more in the solid form; doubt was expressed as to the perfect freedom of the caustic soda from lead. Editorially, attention is called to the fact that the calculated voltage for the decomposition of solid sodium chloride is a little over four volts, and that therefore the heat required for the fusion appears to supply a portion of the energy absorbed in the decomposition, or that in the fused state sodium chloride is about halfway to the point at which it would be dissociated; the efficiency of 85 per cent. for the wet process is questioned.

Electrolysis of Alkaline Salts.—The Lond. "Elec. Rev.," May 11, calls attention to a recent paper by Mr. Arrhenius in the "Zeit. Phys. Chem.," volume XI., page 805.

Electrolyzers.—"La Lum. Elec." frequently contains short illustrated descriptions of various electrolyzers, which

will hereafter not be noticed in these columns, as they appear to be taken from patent specifications without regard to merit or practicability.

Electrolytic Iron.—In a recent paper before the Iron and Steel Institute, by Prof. Arnold, he stated that traces of carbon and sulphur appear even in electrolytically deposited iron.

Hermite Process.—According to "La Lum. Elec.," April 28, Mr. Landin reports to the municipality of Paris that the process appears to be costly, that the disinfecting action of the liquid is not demonstrated, that the liquids after treatment contain more bacteria than those treated with the city water, that the sterilization is not sufficiently rapid, and that there is therefore not a sufficient guarantee.

Chloride Accumulator.—In an article by Mr. Andreoli, begun in the Lond. "Elec. Rev.," May 4, he criticises very severely the recent statements made by Mr. Gibbs in the American papers; he gives great credit to the E. P. S. Company in developing the present accumulator in England; he asks what the "new principle" is, stating that it cannot be the casting of chloride of lead, as this was known for years; he claims that he is in a better position than any one else to say who discovered this principle; he believes no judge in England or America can be found who will agree with the French judges in declaring that fused and cast chloride of lead constitutes an infringement of the Faure battery; he denies the statement of Mr. Gibbs that the French company did not pay the Faure company, and states that they did pay about $270,000.

Peyrusson Accumulator.—An illustrated description of this accumulator, which has already been described, is given in "La Lum. Elec.," May 5; it is of the Plante type and consists of two cylinders made of laminated lead foil; a capacity of 12 to 15 ampere hours per kilogram of plates is claimed, as also a permissible discharge current of 5 to 10 amperes per kilogram.

Porous Peroxide of Lead for Accumulators.—Mr. Fitz-Gerald, in the Lond. "Elec. Rev.," May 11, states that the deca-hydrated sulphate of soda in very fine crystals is much more suitable than sulphate of magnesia, but that there are some inconvenience and uncertainty in using it, and that anhydrous sulphate of potash is preferable; he claims that it is better to make only the surface of the plates porous so as not to sacrifice mechanical strength.

Concentration of Sulphuric Acid.—The Lond. "Elec. Rev.," May 11, states that according to the "Chemiker Zeitung" electrical heat has been adopted for the concentration of sulphuric acid; in order to produce 100 kilograms at 66 degrees, it is necessary to concentrate 117 kilograms at 60 degrees of the acid, which is the strength at which it is usually produced; a calculation of the calories required, including all the losses, is given, and is 32,679 calories, from which it is calculated that it is equivalent to 44.2 h. p. per (!) hour, or allowing for radiation losses, about 50 h. p. per (!) hour (by which is meant that 32,679 kilogram centigrade calories per hour are equivalent to that power, and not that that power per hour is equivalent to that much heat); to accomplish this by electricity will cost about $5 per ton at one cent per hour horse power, which is said to represent a great saving over the usual methods; platinum wire is used and is raised to 480 degrees C. by 365 amperes at 5 volts, the wire being 0.5 centimetre in diameter and 77 centimetres long; in five hours 24 kilograms are concentrated.

Formation of Floating Metallic Leaves.—A paper by Messrs. Mylius and Fromm from "Wied. Ann.," volume LI., page 593, is abstracted in the "Elek. Zeit.," April 26. A zinc disc 5 square centimetres is made the anode in the bottom of a shallow vessel containing a 50 per cent. zinc solution 2 centimetres deep; if a fine wire is barely dipped in the solution over it and made the cathode and a current of three volts is passed through it, an arborescence will be formed which will float on the liquid, especially if oil, such as turpentine oil, is poured over the top, in which case it will form between the two liquids; the experiment may be made with silver, copper and other easily oxidized metals, but not with difficultly oxidized metals, such as nickel, gold and platinum.

Chemical Industry.—An article by Mr. Rigaut in "La Lum. Elec.," May 5, discusses briefly several processes and gives an index to all the papers on electro-chemical subjects in that journal for a number of years past.

Electrical Production of Chemicals.—"La Lum. Elec.," May 5, describes briefly the production of chloral, chloroform and other chemicals by means of electricity.

Capacities of Polarization.—A paper by Mr. Bouty is abstracted in "La Lum. Elec.," May 5.

MISCELLANEOUS.

Compass for Automatic Steering.—An interesting device by Mr. Bersier is described and illustrated in "L'Ind. Elec.," April 25; the object is to operate the rudder of large vessels automatically by the compass directly without the use of the usual seaman. Attention is called to the fact that the errors in the ordinary method are scarcely less than from 1 to 2 degrees, corresponding to a lateral error of about 12 miles per day; with the present method greater accuracy is said to be possible; the standard compass is used and a current from a Ruhmkorff coil is passed from the pivot of the needle to the north pole extremity, whence sparks of 3 millimetres' length pass to one of two semi-circular pieces of aluminium insulated from each other, the gap between them being set to the desired sailing direction; when the spark passes to one of these, the current, by means of a relay, starts a motor in one direction, which in turn operates the rudder, while if the spark passes to the other piece, it moves the rudder in the other direction; the apparatus has been in use for two months on the steamer Neptune, and it operated very successfully; an additional device is mentioned, in which these sparks pass through a strip of paper, by means of which the record is automatically kept.

Electrical Engineering.—Prof. Kennedy's address, the first part of which was noticed in the Digest May 19, is concluded in the Lond. "Elec. Eng." and continued in the Lond. "Elec.," May 4; it is devoted almost entirely to the mechanical engineering features of lighting stations and includes a number of diagrams of loads of different stations and for different periods; among other things he states that in an electric lighting station the cost of coal averages not far from four-tenths of the total working expenses; regarding the losses in the electric transmission, he mentions that in a certain low tension system calculated for a maximum loss of 20 per cent. in the feeders, the actual average loss throughout a whole year amounted to 10 per cent., while in the mains and transformers of a high tension alternating system they are not less than 25 per cent. of the energy generated, which he thinks will be considerably reduced if banked transformers are employed, but he believes that the losses will never be as low as with a low tension system.

Relation of Mathematics to Engineering.—The Lond. "Elec. Eng.," May 4, reprints a lecture by Mr. John Hopkinson on this subject; it is discussed editorially in the Lond. "Elec." and "Elec. Rev.," May 11.

Artificial Rubber.—In an article in "Revue Universelle," mentioned in "La Lum. Elec.," May 5, it is stated that a material serving all the purposes of natural rubber may be made by passing the vapors of the essence of turpentine from below up, through a heated tube of 2 to 3 millimetres in diameter and by passing a jet of atomized hydrochloric acid over the mouth of this tube; the acid with these vapors is said to form small particles of solid rubber.

Electric Smelting.—In a brief article in the Lond. "Elec. Rev.," May 11, some recent improvements are mentioned, among which are that of Mr. Wilson, in which he mixes with the metallic ore finely divided or pulverized carbon, in

order to avoid the intermittent sputtering, foaming and boiling up of the mass which short circuits the arc and produces irregular action; the improvement of Mr. Niewerth is to use an airtight furnace to avoid the contact of air with the heated mass, the atmosphere in the furnace being then composed of carbon monoxide, which absolutely prevents oxidation; favorable mention is made of a review of the recent progress in the electro-metallurgy of aluminium in "Dingler's Journal," volume CCLXXXIX., page 129, and another in the "Zeit. fuer Ang. Chemie," volume XVII., page 515.

Ancient Lightning Rods.—The "Elek. Zeit.," May 10, calls attention to the fact that several of the Egyptian temples were provided with true lightning rods, mentioning the one at Dendrah, which is provided with several pointed wooden poles covered with copper, the purposes of which were found recorded in inscriptions on stone; another, at Medinet Abu, built by Rameses III., about 1300 B. C., in which the points of the rods were gilded.

Height of the Aurora Borealis.—"Cosmos," April 25, quotes from the Transactions of the University of Toronto of 1893, stating that from two observations made of the aurora borealis July 15, 1893, it was found that its height above the earth was about 160 miles.

Gangrene.—According to "L'Elec.," April 28, a Russian chemist, Prof. Allorosoff, has found a simple means to check the progress of gangrene without resorting to amputation, consisting in a simple application of an electric current.

Antwerp Exhibition.—A brief article of a general character by Mr. Bathurst is given in the Lond. "Elec. Rev.," May 11, from which it appears that it is yet far from being completed.

Capstan.—The "Elek. Zeit.," May 10, abstracts from "Engineering." an illustrated description of a form used in England.

Phonograph.—The "Elek. Zeit.," May 10, publishes an illustrated description of the phonograph of Mr. Koeltzow, of Berlin, which is said to be very much simpler than the Edison phonograph and quite as good.

The Postal Telegraph-Cable Company's Celebration.

The jubilee of the telegraph was appropriately celebrated by the Postal Telegraph-Cable Company by the formal opening of its magnificent new building on the corner of Broadway and Murray street, New York City. The Postal Telegraph-Cable and Commercial Cable companies called together as many of the superintendents, managers and heads of departments from all of their more important stations as could be spared from their posts, and after giving them an opportunity for a thorough inspection of the most important office of the combined systems, entertained them at a banquet on the evening of May 24 in the new building. The dinner was prepared in the kitchen of the Hardware Club, at the top of the Postal Building, and served in the large room on the second floor overlooking City Hall Park and Murray street.

Nearly 150 of the officers and employes of the two companies and their allied companies were present. Mr. John W. Mackay presided and Mr. A. B. Chandler, president and general manager of the Postal company, and Mr. George G. Ward, vice president and general manager of the Commercial Cable Company, from their places on Mr. Mackay's right and left, assisted him by acting as toastmasters. The dinner was a most excellent one and thoroughly enjoyed by every one present.

When Mr. Mackay arose to speak, he was greeted with a most flattering ovation, which evidenced his great personal popularity. He introduced Mr. Chandler, who made a most graceful and pleasing address. He briefly traced the history of the telegraph, ascribing to Prof. Morse the title of "Father of the Telegraph," while recognizing the work of Henry, Vail and others. He paid a handsome tribute to the part Mr. Mackay had played in the development of the telegraph, and said a few words about the splendid new home of the company.

Mr. Ward followed with a happy speech. He stated that he had disclaimed any connection between the Commercial Cable Company and the Postal company until Mr. Chandler assumed charge of the latter. Since then he had been proud to claim relationship. He called attention to some of the difficulties that the Cable company had to contend with and made recognition of the immense benefit the Postal company had proved to them. In closing he proposed the health of Mr. Mackay, which was most heartily responded to. Mr. Mackay spoke briefly, as is his wont, expressing his pleasure in welcoming the visitors and his appreciation of the devotion of all the employes to the interests of the companies. Speeches were also made by Mr. John W. Mackay, Jr.; General E. B. Fowler, Messrs. Phillips, of London; W. H. Baker, of New York; J. Furze, of Liverpool; L. D. Parker, of Chicago; C. R. Hosmer, of Montreal; L. W. Storror, of San Francisco; T. J. Wilmot, of Waterville; Tuttle, of Minneapolis; J. G. Ogden, of Montreal; R. S. Gough, of Chicago; S. S. Dickinson, of Canso; L. Lemon, of Baltimore; H. J. Kinnucan, of Detroit; E. J. Nally, of Chicago; F. W. Jones, George Clapperton, G. H. Usher, E. C. Platt and Charles Cuttriss, of New York.

The American Street Railway Association.

The Executive Committee of the American Street Railway Association announces that Machinery Hall, of the Piedmont Exposition Company, of Atlanta, Ga., has been secured for the exhibition of street railway supplies and manufactures, in connection with the thirteenth annual meeting of the association, to be held in the city of Atlanta, commencing the third Wednesday in October (the 17th), 1894, and lasting three days. The building has been engaged for two full weeks, beginning Oct. 10 and ending Oct. 24, thereby giving ample time for the removal of the largest exhibits. Several intending exhibitors at Milwaukee were sadly disappointed by the non-arrival of their goods until after the meeting was over. This was in large part due to the congested condition of freight traffic on trunk lines, owing to the World's Fair and the nearness of Milwaukee to Chicago. It is advisable to secure a time limit delivery; better still, to ship in plenty of time. The convention hall is in the same building on the ground floor, and the railroad facilities for freight purposes cannot be surpassed, inasmuch as the tracks on one side run the entire length of the building. It may be mentioned that some of those who exhibited at Milwaukee have already applied for space at Atlanta. This is, perhaps, the best evidence of the value of making exhibits at these annual meetings, where street railway men gather in large numbers from all over the United States and Canada.

Those desiring to secure space should apply as soon as possible to Mr. N. W. L. Brown, chairman of exhibits, Equitable Building, Atlanta, Ga., or to William J. Richardson, secretary, 166 Montague street, Brooklyn, N. Y.

Elecric Motors vs. Steam Engines.

According to a writer in the London "Electrical Engineer," 30 tons of coal were saved per week in the iron works of Messrs. Dorman, Long & Co., Middlesbrough, by replacing the individual steam engines by electric motors.

Ethereal Draughts.

"The ether blows through the solid mass of the earth like the wind through the trees."—Tyndall.

Variable Speed Motors.

To the Editor of The Electrical World :

In your Digest for May 19, under the title "Variable Speed Motor," you note that "L'Elec." for March 31 describes and illustrates an installation in a French factory, in which both the generator and motor fields are separately excited, and the motor field is kept constant, and the speed of the motor varied by varying the strength of the generator field.

This is one modification of my method of control, and is fully patented in France as well as in the United States. The United States patent is No. 463,802, of Nov. 24, 1891. I call attention to this, as it is apparently described in "L'Elec." as something new.

In your Digest for May 26, under the title "Variable Speed Motors," you note that in the "Elek. Zeit." of April 19, Mr. Baumgardt describes a system of distribution for factories in which two generators of different voltages, say, 50 and 100 volts, are connected in series, making a three-wire system, and motors connected across the three voltages, 50, 100 and 150, in order to secure variations in speed. This system is another modification of my method of control, and is fully covered by my United States patent, No. 478,344, of July 5, 1892. Since the matter is spoken of as though Mr. Baumgardt were the original inventor, I call your attention to my patent.

New York City. H. WARD LEONARD.

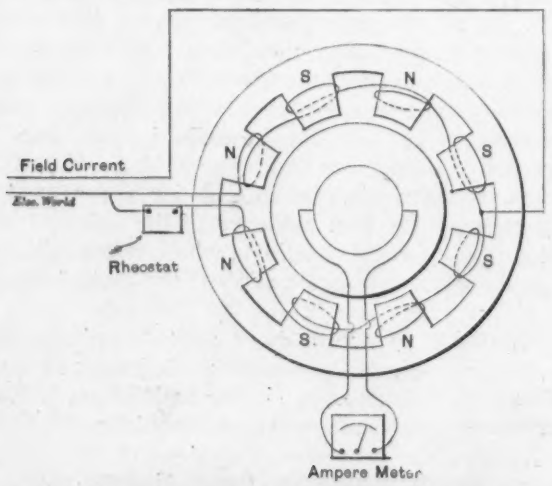
Simple Method of Testing Large Dynamos.

BY G. M. WARNER.

A scheme I have often used for testing large dynamos but have never seen in print may be of interest. The name of the originator of the method has slipped my memory.

We often wish to know the effect of a run at full load on the temperature of a dynamo, and in the case of very large machines a long run is very expensive. By this method, any multipolar machine with series wound armature can be so tested, using only about 3 per cent. of its rated horse power.

The accompanying illustration gives the connections, the fields being separately excited and so connected that half of the poles are reversed from their normal polarity. With the machine at full load and normal current in the fields, we get



SIMPLE METHOD OF TESTING LARGE DYNAMOS.

no potential at the brushes, for the voltage generated in one-half of the armature is equal and opposite to that generated in the other half. If we weaken the current in one-half of the poles by a very little, the opposed E. M. Fs. are no longer equal and we get a potential difference of a few volts.

Hence, driving our machine at full speed and exciting the fields with their normal current, being careful that the adjustments are right to give zero potential, we short circuit the machine by an ampere meter, then very slowly weaken half the fields until full load current flows in the armature. So we have full load currents in the armature and fields, the amount of weakening being negligible, nearly the same iron losses, and only have to supply energy for hysteresis and resistance losses.

With alternators, the weakening of the fields is somewhat more, as we have to supply the self-induction voltage of usually 800 volts, still the results obtained are accurate for most commercial purposes.

A Large Southern Water Power.

BY H. C. MIDDLETON.

Augusta, Ga., has the largest water power of any Southern city, having available for manufacturing purposes the entire Savannah River, the eighth river in size in the Union, being next larger than the Hudson. In 1872 the Augusta Canal and Water Power Works were completed at a cost of nearly $2,000,000, consisting of a massive stone dam, thrown entirely across the river seven miles above the city, and a canal seven miles long to the city with two miles of levels within the city. From this construction 14,000 h. p. were made available in the city for manufacturing purposes, which fact has made Augusta the first manufacturing city in the South. She is the largest cotton and the largest lumber manufacturing city of the South, besides manufacturing heavily in numerous other lines, beer, fertilizers, flour, machinery, glass, clothing, liquor, tobacco, etc. Only 10,000 of the horse power made available is yet taken, though the remainder will doubtless soon be absorbed. When that is done, the raising of the dam will throw perhaps 15,000 h. p. more into the city, and this will be taken by new manufacturing establishments, which are constantly coming to the South to manufacture for this market.

The point in this development that is of especial interest to the readers of The Electrical World is this: here is a great manufacturing city, with a still greater future, with a vast water power, owned by the city and leased out indefinitely at the remarkably low rate of $5.50 per horse power per year. The canal and water power have, however, up to this time conduced only to the building up of large manufacturing plants, the power, on account of the cost of tapping the canal, constructing wheel pits, etc., not being available for small industries. By the construction of an electrical plant these industries would teem throughout the city. Factories would also be enabled to start up and be built in suburban spots and at points without the city that cannot do so on account of the unavailability of power.

An Electric Elevated Railroad.

The officers of the Baltimore and Randellstown Railroad Company, of Baltimore, Md., after a thorough examination into the Barrows elevated railway system, the invention of Mr. C. D. Barrows, of Willimantic, Conn., have decided to give the system a trial on a 4 1-2 miles road that will be built under their charter, from Randellstown to Pikesville, Baltimore, Md. Mr. L. E. Walkins, of Baltimore, states that the rolling stock of this system is much lighter than other storage battery systems, the driving mechanism being 50 per cent. less in weight. He professes great confidence in the Barrows system, and states that the line will be built at once, the money having been raised.

An Electric Carriage.

In the description of the Cummings electric carriage in our columns last week we omitted to state that the batteries used for the propulsion of this vehicle were the cells of the well-known chloride accumulator type made by the Electric Storage Battery Company, of Philadelphia.

Power Brakes for Electric Motor Cars.

BY EDWARD C. BOYNTON.

A system of power brakes for electric cars entirely under the control of the operator is not a difficult thing to devise, provided the same general plan adopted in steam roads and some cable roads be followed. But the conditions entering into the problem, as applied to electric cars, are widely different.

Perhaps the principal difference is the question of economy. In most places where power brakes are used, no notice is taken of the cost of generating the brake power, and yet in most brake systems this power is to a greater or less extent being constantly generated and wasted when the brakes are not in use. It is not likely that this condition of things would suit the manager of a power station operating a large number of cars when he saw its effect on the load diagram of the station.

In short the conditions under which a power brake system may be applied to electric cars are these: (1.) It must be under perfect control of the operator, so that he may vary the brake pressure by degrees throughout its whole range. (2.) It must not consume any electric power (if such power is used at all), except when the brakes are in use. These two conditions seem to point immediately to an electric brake controlled by a switch and rheostat, but there are other methods which also fulfill the conditions.

The two best known brake systems are worked immediately by compressed air or vacuum. The former is obtained either by the well-known steam actuated air pump, or by a simple air pump connected by an eccentric to the axle of the car. The latter is commonly obtained by a steam ejector, the exhaust from which is familiar to those who have seen the cloud of steam rise from the tin-can-like object on top of the cab of an elevated railroad locomotive when entering a station. This latter system, which is not automatic (that is, it will not set itself if the train parts), is an example of a brake that only uses power when it is in use, and requires no cumbersome reservoirs under the cars. The same system could be applied to an electric car with no change except that a small electric motor direct connected to an air pump, possibly a centrifugal pump, be used to take the place of the steam ejector and exhaust the air from the brake diaphragms. The whole apparatus could be placed under the car and enclosed to keep out dust and dirt. This small motor, probably of 2 or 3 h. p., could be series wound, and with a very small rheostat and a release valve, the brake would be under perfect control.

Such a system of vacuum brakes as is in use on the Brooklyn Bridge cars would not be economical, as it consists of a reciprocating pump worked by an eccentric on the axle. This pump exhausts the air from a large reservoir under the car, and is always at work when the car is in motion.

The same objection applies to a compressed air system worked the same way, except that the pump compresses air in a somewhat smaller reservoir.

Steam railroad men have had a wide experience with various brake systems at the annual brake tests on the C., B and Q. R. R., at Burlington, Iowa. Among those tested in past years have been several so-called electric brakes, consisting of what is really a momentum brake applied and released by an electric current furnished by a few cells of battery on the locomotive. Upon the axle of the car is mounted a drum, to which is attached a sort of a clutch, which, when a small electromagnet releases a catch, engages the drum and starts to wind up a chain, which in turn pulls on the brake levers. A powerful spring, which can be adjusted along a central rod, is arranged to pull against the drum, so that the apparatus can be adjusted to give any predetermined pressure at the brake shoes, the clutch slipping when the pressure is reached and is thrown out of gear and the brake released by the electromagnet.

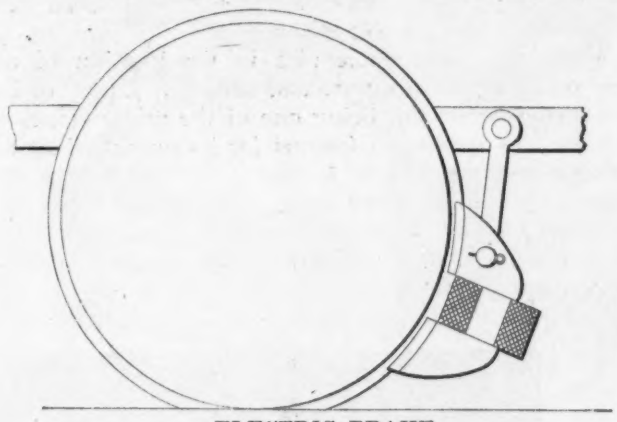
This works very well with one exception; it is not under complete control, and there is no means of graduating the pressure. If the car or cars are light, the pressure for which the brake is set may be meant for a loaded car, consequently the wheels skid, producing the railroad man's bugbear, "flat spots" on the wheels.

The principal objection to this brake was its liability to get out of order, and that the "engineers were not electricians," and so could not keep it in working order. Neither did they understand the wonderful airbrake now in common use until they had been trained in its operation and repair. However, this objection hardly applies to an electric car, for there are always a number of men connected with the road who could readily understand such an appliance.

But there is no doubt that the utilization of the momentum of an electric car to apply the brakes would be the most economical and the best method if it could be properly controlled, and it is certainly possible to do it on one car.

Whatever the system of power, an electric car should have a brake shoe upon each wheel with the leverage so proportioned as to give an equal pressure on every shoe. The writer recalls a locomotive tender brake worked by air which always wore out two pairs of rear wheel shoes to one pair in front. Such things used to be quite a puzzle to the round house foreman.

In locomotive driver brakes, it is the common practice to make the brake pressure attainable equal to from 60 to 70 per cent. of the weight on the wheel. This is usually sufficient to lock the wheels on a dry rail, so that the brake has some surplus power. It is well known that a car with locked wheels will slide considerably further than one will run with its wheels turning and the brake on as hard as possible. In order to stop in the shortest distance, the brake must be applied as strongly as possible at first and the pressure gradually reduced as the speed lessens to prevent locking the wheels. We see this done, or rather feel it, on every steam railroad we travel on.



ELECTRIC BRAKE.

The best stop and the one that motormen should practice when power brakes come into use, is called a "uniformly accelerated stop." The name defines it, but perhaps the following expresses it: It is a stop which, after the first application of the brake, will not disturb the equilibrium of a person standing in the car. It is evident that the most delicate control of the brake power is necessary to do this, and on steam roads it is rarely done.

An electric brake, pure and simple, is perfectly practicable in the writer's opinion, and would probably consist of powerful electromagnets rubbing on a revolving keeper.

If these can be made powerful enough they would undoubtedly work well. The first form that naturally suggests itself is shown in the sketch.

This, if the writer is not mistaken, appeared in one of the late Mr. Van Depoele's early patent specifications.

The theory of the brake and of rolling friction, as laid down in many text books on mechanics, rarely agrees with results obtained from actual experiments with a train, for the reason that the humidity of the atmosphere and even the height of the barometer, greatly affect the results obtained.

Frankfort (Ky.) Electric Railway.

In the great distillery district of Kentucky, or "Blue Grass" region, as they call it, little or no attention has been given to the matter of transporting the output or supplies of

ENGINE AND DYNAMO ROOM.

the distilleries, their whole idea in the location of these plants being given to a pure and sufficient supply of limestone spring water, this being one of the prime causes that has made this section so famous for its output of superior whiskeys, and the Capital Railway, of Frankfort, is to be congratulated on being the initial enterprise in Kentucky to give these distilleries cheap transportation for their grain, coal and wood to their plants and their output of whiskeys to the steam railway connection. In the city of Frankfort, daily, long lines of heavy wagons could be seen handling this business, which is now being done in an entirely satisfactory manner by the little "Lightning Bug," shown in Fig 1.

The power house is a substantial brick building, 52 by 125 feet, with a double track car barn 26 by 125 feet attached. The boiler room, which is separated from the engine room by a brick partition, is 35 by 52 feet, and contains 200 h. p. capacity boiler plant, with heater, boiler feed pumps, etc. Fig. 2 illustrates the engine and dynamo room, in which two 100 h. p. Jenney dynamos are driven by one of the latest type of Dick & Church tandem compound engines of 200-h. p. capacity.

The switchboard is of the improved Jenney type, with marble panels, and all connections are made from rear of board. The instruments used are of the Weston make. The electrical station equipment was furnished and installed by the Jenney Electric Motor Company, of Indianapolis.

Tests of the generating plant have been made with very heavy overloads, the apparatus showing remarkable results in the way of regulation and capacity.

The freight motor car is of a special design, 28 feet in length, mounted on a pair of heavy trucks, with five-foot wheel bases, the body being extra heavy, built to withstand the severe strain of having loaded freight cars as trailers, and in appearance is very much like an ordinary baggage car, as used on steam roads. Fig. 4 illustrates this car hauling three box cars around a curve.

Four 25-h. p. motors, controlled by a single specially de-

ELECTRIC FREIGHT CAR.

signed controller, are attached one to each of the four axles of this car, making each wheel a driver. The total weight when empty of this car and equipment is 15 tons, and when not used for handling full loads is used for handling small shipments, barrels and boxes.

Besides the freight motor car described above, three 18-

foot closed passenger cars, handsomely finished, painted a light and attractive color, are used. These cars are equipped with 25-h. p. motors and haul trailers. The cars were made by the Barney & Smith Car Company, of Dayton, Ohio.

The track is a 56-pound T rail, laid on 6″ by 8″ by 8′ white oak ties, two feet between centres and ballasted with crushed blue limestone rock. Heavy cuts and fills are numerous, the nature of the country through which this road runs being mountainous and the grades severe, being in some instances as heavy as 8 per cent., and in one instance a reverse curve was necessary on a 7 per cent. grade, but even here absolutely no difficulty was experienced in handling from one to three heavily loaded box cars with the freight motor car.

The overhead line is of the Creaghead flexible side bracket construction, specially made for high speed roads in the suburbs, but in the city is of side pole and span wire construction, using No. 0 trolley wire.

Frankfort is a city of about 10,000 people, capital of the State, with numerous manufacturing establishments, and so situated that it covers a large area, making the four miles of track used for passenger traffic very profitable, in addition to which the management has a beautiful park, containing about 40 acres, situated on an elevation of about 500 feet, overlooking the city and river, with a baseball and football ground and grand stand, dancing pavilion, band stand and numerous summer houses, nice walks, rustic seats and other attractions.

The design and construction of this road were done for the contractor, Frank Whitley, of Springfield, Ohio, by the Creaghead Engineering Company, of Cincinnati, under the personal supervision of George B. Scrugham. The stockholders of the local company are the principal business men of the city. Patrick McDonald is president, and John T. Buckley is secretary and general manager.

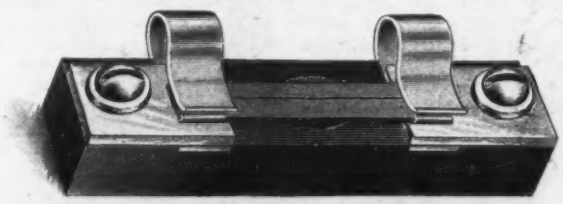
The Gillette Interior Telephone System.

In the description in our issue of May 19 of the Gillette interior telephone system, we omitted the name and address of Mr. Alexander S. Williams, 120 East Thirteenth street, New York, who is placing the apparatus on the market.

Fuse Link and Block.

The question of protection for fine wire, such as used on delicate and costly instruments and fuses, which would be of service for telegraph and telephone work, has long remained without satisfactory settlement. It has seemed to be impossible to produce a wire from fuse metal by ordinary means which would fuse at as low a current as one-half an ampere. Copper wire drawn to .002 inch is found to carry more than one ampere of current without melting. Various means have been resorted to for making low melting

FUSE LINK.



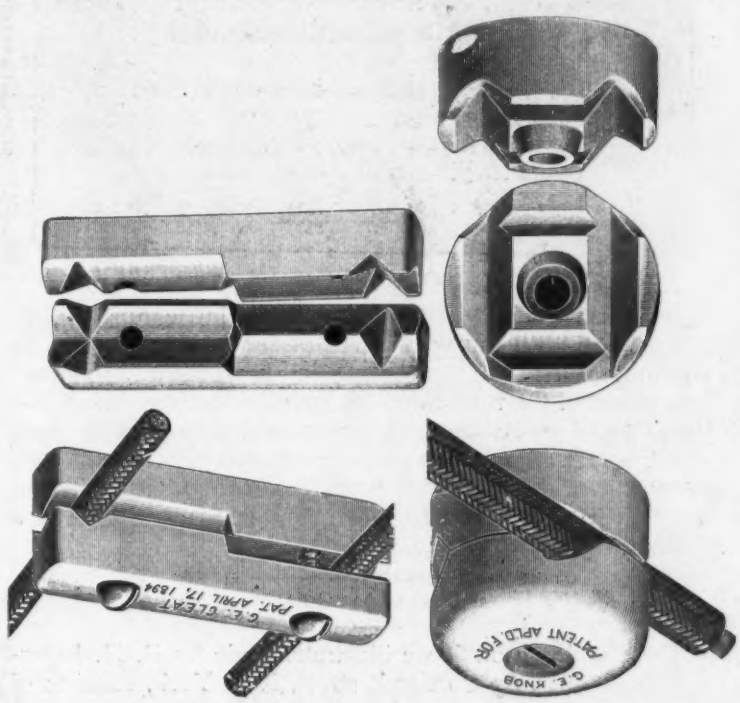
FUSE LINK AND BLOCK.

fuses, such as slitting up tinfoil, etc., but all such fuses have proved to be inaccurate and unsatisfactory.

The accompanying cut illustrates a new fuse link from the laboratory of the Independent Electric Company, 39th street and Stewart avenue, Chicago, which is claimed by them to be as true to size and rating as other samples of their well-known tested fuse wire. The wire used in these fuses is produced by a new process from a special alloy, and although very expensive, both for the jewel dies and cost of making, it is found to perfectly accomplish the much desired end. They are now making fuse links in this form, in commercial quantities, which fuse respectively at 1-2, 3-4 and 1 1-2 amperes of current. We also illustrate a block designed and made by this company for holding these fuses.

Porcelain Electric Fittings.

The General Electric Company has lately designed certain new porcelain wiring appliances to meet the insurance requirements. The cleat is formed of two pieces exactly alike, in which the groove is so shaped that it will take a wire up to 5-16 inch in diameter, and the wires are 2 1-2 inches apart, as specified in the insurance rules. The knob is designed to hold wires from 3-16 to 1-2 inch, and do away with the unsightly tie wire. The top and bottom are each provided with



PORCELAIN FITTINGS.

four grooves of different dimensions, that any wires within the range given may be firmly secured. This knob is 1 1-2 inches high and 2 inches in diameter, the wire being held 1-2 inch from the ceiling. The floor and window tube has a central hole 5-8 inch in diameter and a head 2 1-4 inches in diameter. It is 1 3-8 inches outside diameter and 3 3-4 inches long. These porcelain appliances are of the best, hard white vitrified non-absorbent porcelain of highest resistance.

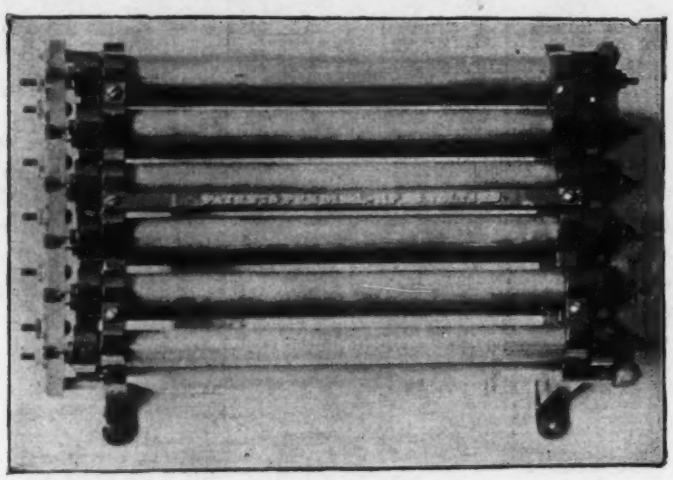
A New Rheostat.

We illustrate herewith a new form of rheostat, designed by Mr. Whittingham, and recently patented by the Automatic Switch Company, of Baltimore, Md. The principle followed in the construction is that of enclosing each resistance coil in a tubular heat radiating casing, the space between the wire and the tube being filled with a good heat conducting medium, and the grouping of a sufficient number of tubes in such manner as to allow a perfectly free circulation of air among them.

In appearance the rheostat is not unlike a small steam radiator, and its area, in proportion to its bulk, is very great. The rheostat shown in the photograph measures over all 10

by 15 inches by 2 1-2 inches thick, but its radiating area, in square inches, is something over 625.

Each tube of the rheostat is a complete ironclad resistance with a connecting terminal at each end. It is 15 inches long by 1 1-8 inches in diameter, and has an area of 52 square inches. One tube is capable of absorbing and radiating safely 250 watts of energy, and the method of construction is so flexible as to allow a single tube to be wound to stand a pressure of 500 volts. It will be seen from the figures given that the full capacity of the rheostat illustrated is a continuous radiation of 3,000 watts, but for work of an intermittent character, such as motor starting, the amount of energy can be more than doubled with perfect safety.

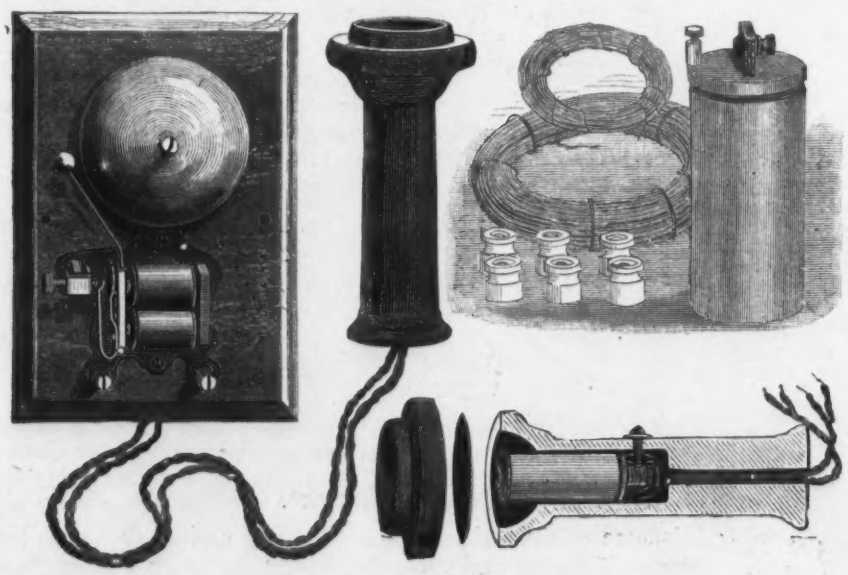


A NEW RHEOSTAT.

It is very evident that the tubular jacketing exposes, in comparison with the actual area of the resistance wire, an enormous surface to the cooling action of the air. The arrangement of the tubes, with air passages between them, has the effect of producing a strong draught as the hot air rises, which forces a continuous supply of fresh, cool air through every part of the rheostat. So perfect is this circulation that it requires nearly 800 watts to maintain a single tube at a dull red heat.

Telephone Outfit.

The telephone outfit we illustrate, made by R. H. Ingersoll & Brother, 65 Cortlandt street, New York, consists of a receiver transmitter, call bell and battery for each end of the line, with material for a short line and connections.



TELEPHONE OUTFIT.

The receiver and transmitter is a combined instrument, into which the message is delivered and from which it is received. It is made in substantially the same manner as regular "Bell" receivers, and will do exactly the same work in ordinary use. The call bell is of a special type, made solely for this outfit, and is capable of very fine adjustment, so as to be operated over long distances. That ordinarily furnished with the outfit is constructed to ring for a distance of one mile and under, but bells of greater capability are furnished for longer distances. The bell is mounted on polished hard wood backboard, and the whole handsomely finished. From the board, the receiver and transmitter is suspended by a telephone cord and at the back of the board, concealed from view, are the switches and connections, which are automatically operated by two push buttons at the side of the board, one to ring up and the other to connect the telephone with the line wire and battery. The batteries are of the best "dry" type, made especially for the outfit, with a view to long life and strength.

An Automatic Tapping Machine.

We illustrate herewith an automatic tapping machine recently placed on the market by the Garvin Machine Company, of Laight and Canal streets, New York, which is adapted especially for use in the manufacture of hardware specialties, electrical goods, etc. In designing it the object has been to combine lightness, strength, ease and rapidity of manipulation, together with accuracy and uniformity of the work produced. The spindle is fitted with two loose friction pulleys, driven in opposite directions by one continuous belt. Between these pulleys is a friction clutch keyed to the shaft, which is thrown into the driving pulley by the downward pressure of a hand lever at the right. The tapping then proceeds, and is tripped and reversed automatically at any point in the operation by an adjustable stop on the upper end of the spindle coming into contact with a reversing lever at the top of the machine or by moving this lever by the hand. The spindle is balanced and fitted with a chuck for holding the taps. The table is rectangular, has an oil groove around it, and is adjustable up and down the column to suit the work. A feature in this tool is that it operates satisfactorily at high speed and will trip and reverse after being set, even though the operator should continue to press down the starting lever. The principal dimensions of the machine are: Diameter of spindle, 1 inch; diameter of the largest hole that can be tapped, 5-16 inch; motion of spindle, 2 1-2 inches; dimensions of table, 12 by 18 inches; adjustment of table on column, 20 inches; tight and loose pulleys on countershaft, 6 by 2 1-2 inches; speed of countershaft, 200 revolutions; net weight complete, 300 pounds.

AUTOMATIC TAPPING MACHINE.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, May 26, 1894.

THE ELECTRICAL STOCK MARKET is profiting by the inactivity marking the course of the general stock market, and is participating in the attention that all classified securities are receiving.

GENERAL ELECTRIC must be treated of first, in view of the prominence this week of the transactions in the stock. Most of the dealings of the week have been on the bear side of the market, but in the last day or two some strength has developed. This was more due, however, to the covering of short contracts by the bear traders than to any buying for either bull or investment account, and the week closes with the advantage decidedly in favor of the bear position. A flood of gossip and news relative to General Electric has accompanied the activity in the stock. Most of it is of a depressing character, though here and there some item of a cheering nature has appeared to give courage to security holders. The most important piece of news is the semi-official announcement that the plan to make good the impairment of assets by reducing capital stock has been abandoned by the management, because of the acknowledged failure to secure the necessary consent of every share of preferred and common stock. The full extent of this decision on the part of the directors is realized when it is stated that there can never be another dividend on General Electric stocks until the impairment is corrected. The directors elected at the annual meeting in April have appointed Messrs. Robert T. Payne and Gordon Abbott, of Boston, to fill the two new seats created by the stockholders at the meeting, and both gentlemen have been placed on the committee that is entrusted with the work of rehabilitating the company. The full board of directors has organized by electing these officers: C. A. Coffin, president; Eugene Griffin, first vice president; Joseph P. Ord, second vice president and comptroller; M. F. Westover, secretary; H. W. Darling, assistant secretary; B. F. Peach, Jr., treasurer. This is the old set of officers, except Mr. Westover replaces Mr. Garfield as secretary. Speaking of the business of the General Electric Company, an executive officer, who recently made a tour of the West, tells one of the Wall Street news agencies that electrical matters are very quiet in the middle western section of the country; much more so, he says, than in the East. The principal demand is for street railway apparatus. Competition is sharp, and prices considerably lower than they were a year ago; however, the General Electric Company is deriving a profit upon all business which it will handle. The company's plant at Schenectady is employing about 2,900 men, while the Lynn plant is employing about 1,400 men, and there was recently an increase in the force at the Lynn plant, owing to an increase in orders for street railway apparatus. The demand for supplies of this nature in the Eastern territory is fairly good. Orders for motors on hand at this date are 800, which is about the same number booked in May, 1893. The prices are from 25 to 30 per cent. lower than they were a year ago. This is made up in part by lower wages and cheaper raw material, and in part by less profit in the business. The cheaper price has stimulated the demand. The tendency of prices, however, is upward.

WESTINGHOUSE ELECTRIC SECURITIES, during all the recent depression in the general stock market, have shown a remarkable degree of steadiness in quotations. Investors are beginning to appreciate in what good financial condition the Westinghouse Electric and Manufacturing Company must be when they note the ease with which it has weathered all the recent financial panics and hard times, and a quiet but continued buying of both preferred and common stock keeps on, the steady demand for the non-dividend paying common stock being an especial tribute to the general belief in the company's ability to make big distributions at an early date among shareholders. Official reports as to business continue very satisfactory. Action on the preferred stock dividend will be taken about the middle of June. It may be that something may be given to common stockholders. A Boston banker, who has been comparing the annual reports of 1894 and 1893, finds that the quick capital has increased $977,082, and securities in treasury $241,400. On the other hand, bills and accounts payable were reduced $801,566 and bonds $50,000. This banker takes the book valuation of franchises and patents, $4,380,000, and deducts the surplus of $3,822,000, which he also treats as a book account, the result, $1,568,000, being considered by him about the true value of the franchises and patents. He makes the undivided net earnings for two years $1,940,622, or 37½ per cent. There is no reason, therefore, unless the company elects to use its net income for construction or working capital, why dividends on the common stock may not be paid this year.

THE AMERICAN BELL TELEPHONE COMPANY furnishes a "straw" as to the improving conditions of business matters in its monthly statement of instrument output. It shows for the 30 days ending May 20 a net output of 3,664 instruments, that number being the excess of new telephones placed in the hands of the subscribers of the various companies, under rental, over the number returned or given up. In March the net addition was 552; in April 2,819. For the seven months preceding March there had been a steady reduction, or excess of instruments returned over output, the net loss being 14,249, but in three months the seven months' loss has been reduced by 7,035 instruments, a very encouraging sign. The Bell company now has a total of 570,011 instruments under rental, a decrease of 2,646 as compared with the number under rental a year ago. In Boston it is now conceded on all sides that the Bell company will get all it asked for from the State Legislature in the matter of the increase of capital stock to $50,000,000.

WESTERN UNION TELEGRAPH has shown more life this week. There has been a good deal of free and easy selling of stock, but it has all been for the short account, and all the attempts to raid the stock have not accomplished much. The bears have endeavored to make capital out of the damage that the storms have wrought on the property of the company, and insist that the losses entailed were such that a reduction in the next dividend is absolutely necessary. There are semi-official and very positive statements, however, that at the meeting of the executive committee on June 12 the regular quarterly dividend of 1¼ per cent. will be declared for the June 30 quarter, as it will have been fully earned. This indicates that the net earnings for the quarter will be in excess of $1,400,000, against $1,050,000 in the March 31 quarter, when but .85 per cent. was earned on the stock. In the June 30, 1893, quarter, the net earnings were $1,750,000.

THE STREET RAILWAY AND ILLUMINATING properties' trustees are again in the market for the sale to them of $60,000 preferred stock.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Detroit Electrical Works	10	2	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref	15	15	16
" " " com	15	15	17½
Edison Electric Ill., New York	100	98	100
" " " 1sts	—	106½	107
Edison Electric Ill., Brooklyn	100	102	103 *
" " " Boston	100	116	117
" " " Chicago	100	130	135
" " " Philadelphia	100	125	127
Edison Electric Light of Europe	—	—	3
" Bonds	—	80	85
" Ore Milling	—	10	11
Fort Wayne Electric	—	3½	4
General Electric Company	100	85¾	85⅞
" " " deb. 5's	—	88	88½
Interior Conduit and Ins. Co	100	50	55
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	30½	27
" " " pref	50	52	53
Western Union Telegraph	—	82	—
American Bell Telephone	—	191	191½

*Ex. Dividend.

New Incorporations.

THE BLACK RIVER TELEPHONE COMPANY, Lorain, Ohio, capital stock $1,000, has been incorporated.

THE WEST SHORE TELEPHONE COMPANY, Highland, N. Y., capital stock $3,500, has been incorporated.

THE NATIONAL TELEPHONE COMPANY, Portland, Ore., capital stock $100,000, has been incorporated.

THE FORT WAYNE POSTAL TELEGRAPH COMPANY, Fort Wayne, Ind., capital stock $20,000, has been incorporated.

THE SYLVAN AVENUE PASSENGER RAILWAY COMPANY, Pittsburgh, Pa., capital stock $12,000, has been incorporated.

THE INDIANA TELEPHONE AND CONSTRUCTION COMPANY, Indianapolis, Ind., capital stock $300,000, has been formed.

THE BUTLER TRACTION COMPANY, Butler, Pa., capital stock $75,000, has been incorporated by Joseph Hartman and others.

THE NORTHERN ELECTRIC STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock $150,000, has been incorporated.

THE STATESVILLE TELEPHONE COMPANY, Statesville, N. C., has been organized by A. K. Klingender, James T. Tindall and A. B. Cooper.

THE MULTOMAH TELEPHONE COMPANY, Portland, Ore., capital stock $100,000, has been incorporated by E. W. Curtis, Chas. Perry and P. Dolan.

THE HARRISON INTERNATIONAL TELEPHONE CONSTRUCTION COMPANY, Jersey City, N. J., capital stock $200,000, has been incorporated.

THE BANNING ELECTRIC CHEMICAL FIRE EXTINGUISHER COMPANY, Jersey City, N. J., capital stock $100,000, has been formed to deal in fire extinguishing apparatus.

THE PORTLAND, VANCOUVER AND NORTHERN RAILWAY COMPANY, Portland, Ore., capital stock $3,000,000, has been incorporated to construct railroads, telegraph and telephone lines, etc.

THE NATIONAL TELEPHONE COMPANY, Salem, Ore., capital stock $100,000, has been formed by E. P. Curtis, D. P. Dolsen and others to do a telephone, telegraph and general electrical business.

THE WESTERN ELECTRIC ACCUMULATOR COMPANY, St. Louis, Mo., capital stock $10,000, has been formed. The promoters are H. Mendenlick, J. Frings, Geo. Boschers, Emil Braun and P. H. Bierman, St. Louis.

THE O. C. WHITE COMPANY, Worcester, Mass., capital stock $16,000, has been formed to manufacture and sell adjustable electric lights and other articles. The organizers are O. C. White, G. E. Francis and David Harrower, Jr.

THE INDIANA ELECTRIC RAILWAY COMPANY, Goshen, Ind., capital stock $25,000, has been formed to operate and construct a road from Goshen to Elkhart, Ind. J. J. Burns, J. H. McIlhenny and W. L. Stone are interested.

THE WATERPORT ELECTRIC LIGHT AND POWER COMPANY, Waterport, N. Y., capital stock $40,000, has been formed to supply electric light, heat and power. L. Beecher, C. A. Seaver and E. C. Long, all of Batavia, N. Y., are the promoters.

THE HONESDALE ELECTRIC RAILWAY COMPANY, Honesdale, Pa., capital stock $100,000, has been formed to construct, maintain and operate an electric railway. W. H. Dimmick,, W. N. Alberty, Honesdale, and M. M. Treadwell, Hawley, Pa., are the promoters.

THE AMERICAN CONSTRUCTION COMPANY, Lancaster, Ky., maximum capital stock $500,000, has been incorporated to construct and operate electric light and power plants, etc. W. H. Kinnaird, R. H. Tomlinson and J. T. B. Twiner, Lancaster, Ky., are interested.

THE NATIONAL SCHOOL OF ELECTRICITY, Chicago, Ill., capital stock $100,000, has been formed to teach the principles of electrical and allied sciences, and to transact all business incident thereto. The incorporators are Walter C. Jones, Geo. L. Cragg and Geo. S. Buell.

THE VAN CHOATE ELECTRIC COMPANY, Portland, Me., capital stock $6,000,000, has been incorporated to manufacture and deal in electrical appliances and machinery of all kinds. S. F. Van Choate, F. W. Willey, Boston, and W. L. Knox, Winchester, Mass., are interested.

THE PEOPLE'S TELEPHONE AND CONSTRUCTION COMPANY, Wheeling, W. Va., maximum capital stock $100,000, has been formed to construct and operate telephone and telegraph systems, etc. J. J. Woods, W. D. Johnson and J. B. Somerville, Wheeling, W. Va., are interested.

THE NONPAREIL ELECTRIC COMPANY, Philadelphia, Pa., maximum capital stock $3,100,000, has been organized to manufacture and sell storage batteries, dynamos, motors, etc., construct electric plants, etc. G. O. Corbron, Jr., T. J. Crosier and E. C. Paramore, all of Philadelphia, are the incorporators.

THE GARDNER ELECTRIC STREET RAILWAY COMPANY, Gardner, Mass., capital stock $50,000, has been formed to construct and manage a street railway through Gardner, South Gardner and West Gardner, length of same to be 3½ miles. L. A. Greenwood, J. A. Stiles and Chas. Heywood, all of Gardner, are the promoters.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, May 28, 1894.

MR. MALCOLM DONALD PECKHAM, brother of Mr. Edgar Peckham, of the Peckham Motor Truck and Wheel Company, who was assaulted by a former employe on May 15, died last week from the effects of the injuries received.

THE CITIZENS' ELECTRIC ILLUMINATING COMPANY, of Brooklyn, has been presented a bill of $9,954 by the water purveyor of Brooklyn for water said to have been surreptitiously taken from the city mains during the last four years.

THE GENERAL ELECTRIC COMPANY has closed the contract for the Poughkeepsie and Wappinger's Falls Railway, of Poughkeepsie, covering two 200-kw. direct connected generators, 40 G. E. 800 motors and type K controllers.

THE NEWTON ELECTRIC COMPANY, 39-41 Cortlandt street, has absorbed the Imperial Manufacturing Company, formerly of 143 Liberty street, and the line cut-outs and indicators of that company will hereafter be made by the Newton Electric Company.

BRIDGE LIGHTING.—Plans and estimates will be received by the chief engineer of the New York and Brooklyn Bridge, at 179 Washington street, Brooklyn, to noon, June 15, for lighting the bridge cars, as per details to be had of C. C. Martin, chief engineer and superintendent.

THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY has offered its subscribers the choice of two plans of paying for telephone service. They can pay $240 and get the latest improved metallic circuit for a year, or they can pay $150 a year if not more than 1,000 messages are sent. If they send more they must pay for the excess on a sliding scale, beginning with 15 cents a message, and gradually decreasing to 5 cents. The new plan is to induce persons who have no great use for the telephone to subscribe at a cheaper rate. The company now has 10,053 stations in New York, including the pay stations, and 75 per cent. of these use the long distance telephone. The company hopes to greatly increase the number of long distance stations by the new plan.

Pittsburgh Notes.

PITTSBURGH, May 26, 1894.

THE SUB-COMMITTEE ON PUBLIC LIGHTING, of Allegheny City, met yesterday and awarded the contract for an addition to the municipal central station plant. The new building will cost $26,000.

THE IRONWORK for the machine shop and warehouse of the new factory of the Westinghouse Electric and Manufacturing Company at Brinton is now completed, and the power house is being put up.

THE ANNUAL MEETING of the stockholders of the Pittsburgh, Allegheny and Manchester Traction Company was held last Tuesday. The report of President John H. Dalzell showed that the gross receipts of the company for the year were $450,912.97, operating expenses and fixed charges $361,146.71. Dividends to the present time $257,110.56, and the net income from the time of the reorganization of the company up to the present time $296,760.24, leaving a balance of $39,849.68. The cash on hand April 30, 1894, was $45,809.24. The general manager reports cost of operating the power station at 1.3 cents per car mile; the cost of electrical energy per kilowatt hour somewhat above 1 cent. The old board of directors was re-elected as follows: John H. Dalzell, Joshua Rhodes, G. B. Hill, Fred. Guinner and Wm. Eberhardt.

TO GET RID OF THE WIRES from the inside of central station plants is a problem that has at one time or other confronted every manager, especially in large plants where the number of wires rapidly accumulates, and thus the risk of fire grows correspondingly as the difficulty of keeping the wires apart increases. The Allegheny County Light Company, operating one of the largest electric light stations in the country, has just completed an arrangement whereby all the wires inside the plant have been placed underground. The company has in operation nine 4,000-light Westinghouse alternators, 26 60-light Brush arc dynamos and two 250-h. p. Westinghouse direct current power generators. The alternators supply incandescent lighting to private consumers and business houses, the arc dynamos supply light to the streets of Pittsburgh as well as business places, and the Westinghouse power generators are used for the supply of power to elevators, sewing machines, printing presses, fans, etc. To abolish the wires from the interior of the station, the company built subways for the wires from the dynamos to the marble switchboard, and also subways for the wires from the switchboard to the outside of the building. For this purpose there are constructed four subways—two from the dynamo to the switchboard, and two from the switchboard to the outside of the building. Two of them contain the incandescent wires, and the others the arc wires and the wires from the power generators. The subways from the dynamos are each 180 feet long. They are constructed of 13-inch brick walls with an arched roof, and the dimensions of the subway are 6 by 4½ feet. The floor is composed of cement, and any water which occasionally accumulates is taken out by steam siphons. The subways are lighted by electric lights, and the cables are carried upon brackets, which are fastened in the side walls. Each bracket carries four cables, allowing ample space for workmen to pass to and fro. The subways are connected with sewers, on account of the close proximity of the station to the river. The subway for the incandescent circuits from the switchboard to the outside terminates in an 8-foot manhole, and from here the wires go to two 65-foot poles, on which the cables are carried to the overhead circuits. The subway for the arc and power circuits, from the switchboard to the street, is constructed the same way as the other, leading also into a manhole, and from there to two 65-foot poles. The pole line, extending from the station to the downtown district, is composed of 65-foot poles, 10 inches at the base and 16 inches at the top. Each pole has 15 six-pin cross arms, which means 90 wires, the latter ranging from No. 6 to 0000 wire.

Canadian Notes.

OTTAWA, Ont., May 26, 1894.

NIAGARA FALLS.—Notice is given that, under the Ontario Joint Stock Companies' act, letters patent have been issued, whereby the capital stock of the Niagara Falls Electric Light and Power Company, Ltd., has been increased from the sum of $40,000 to $75,000.

CARLETON PLACE, ONT.—Application is being made to the Ontario Government for incorporation of the Lanark County Electric Railway Company, Ltd., capital stock $100,000, to build and operate a line from Perth to Lanark. The applicants are John B. Riley, of Plattsburg; Alex. Wendler, Carthage, N. Y.; Thomas Henry, Montreal; A. H. Edwards and James Fowler, Carleton Place. A preliminary survey has already been made with a view to obtaining a direct line, and as the individuals in the company are all practical business men, the project is expected to go forward at once. The towns interested will probably be asked to assist the enterprise.

OTTAWA, ONT.—Lord Aberdeen, Canada's Governor-General, has purchased an electric yacht from the Electric Launch Company, of New York. The launch is 35 feet 10 inches over all in length, and 31 feet 6 inches on the water line. The beam is 6 feet 2½ inches, and the draught 27 inches. It carries 20 people with plenty of room and comfort, and indeed can seat 30. The motor is underneath the flooring of the boat, where it turns the propelled shaft. One man in the bow controls both the motor and the steering. The storage batteries, which can be charged from any trolley or lighting wire, are under the seats. Fully charged, the batteries can give the launch a run of 70 to 80 miles. The ordinary speed is about 6 miles an hour, but a turn of the lever can put this up as high as 10 miles an hour. The cost of running the launch, as far as electricity is concerned, is only about 6 cents an hour at the ordinary rate of speed.

English Notes.

(From our own Correspondent.)

LONDON, England, May 17, 1894.

COST OF ELECTRICAL ENERGY.—The discussion on Mr. Crompton's paper on "Cost of Electrical Energy," recently read before the Institution of Electrical Engineers, has been adjourned to the 24th, the date of the last meeting of the session. The discussion has so far been in keeping with the value of the paper. Mr. Raworth, of the Brush company, as I before stated, opened the discussion on the evening of the reading of the paper. On Thursday last the adjourned discussion was opened by Mr. Crompton, who drew attention to a diagram giving the results of a 24-hour test of a boiler at his Chelmsford station. He showed that when a careful run was made, the pounds of water evaporated per pound of coal rose to a little over 9, although on the year's run the figure only came out at 5.2 pounds. Major-General Webber threw some doubt on the possibility of Mr. Crompton's hypothetical estimates. Mr. Mark Robinson, of Willans & Robinson, hoped that Mr. Crompton's prediction of a consumption of only 2.5 pounds of coal per unit sold might some day be realized, and pointed out that the prediction rested on three factors; viz., the evaporation by the boiler of 12 pounds of water per pound of coal, the consumption by the engine of only 12 pounds of steam per I. H. P. hour, and a very small amount of friction. With regard to the boiler factor, he could only say that Mr. Crompton's figure was beyond present practice. Mr. Robinson, however, corroborated Mr. Crompton's assertions as to the dryness of the steam obtained from water tube boilers. His own company had taken up a water tube boiler from which they hoped great things, and which, in spite of its being forced to double its original capacity, continued only to give ¼ per cent. of moisture. As regards the engine consumption, Mr. Robinson pointed out that the figure of 12 pounds of steam per I. H. P. hour had only so far been obtained by the horizontal slow speed Sulzer engine. The best experimental figure of the Willans engine was about 12.8 pounds, and the best guarantee the firm had ever given was 13 pounds for a large marine engine. Coming to the subject of engine friction, Mr. Robinson controverted some remarks made at the previous meeting by Mr. Raworth, who had stated that the brake efficiency of the Willans engine was only about 89½ to 90 per cent., whilst any double-acting vertical engine could be made to show 92 per cent. Mr. Robinson pointed out that cards taken from an engine running light were really no criteria, at any rate, in the case of the Willans engine, as to its efficiency when running loaded, since, in the case of the Willans engine, two of the four sources of friction were absent, and the remaining two sources of friction were in the Willans engine constant, whilst they tended to increase in ordinary double-acting engines as the load came on. Mr W. Geipel, who has charge of the central station design department of the Brush company, was of opinion that engineers should have a good deal to do in the matter of controlling the first cost of electric light stations. In his opinion the present high price of electric supply was due mostly to an insufficient consideration having been given by engineers to this very question of first cost. What was the use of providing coal or labor saving apparatus if the apparatus cost more than the saving it was proposed to effect. He did not see how the coal consumption could possibly be reduced to 2½ pounds per unit sold, but believed that 4 pounds might be reached even with ordinary English coal. He also cast doubts on the possibility of Mr. Crompton's figure of 12 pounds of water being evaporated per pound of coal. Mr. Geipel then described to the meeting two methods of setting boilers, which he had designed with a view to reducing the losses due to radiation. The one applied to the Babcock-Wilcox boiler consisted in a thermal insulator in the form of an air space effected in the middle of the brick side walls. The other consisted in passing the gases after they had been through a large side flue round each boiler consecutively to the chimney, so that whatever number of boilers happened to be out of use at any time, they were kept warm by the waste gases coming from those in use. Mr. Geipel did not agree with Mr. Crompton that the Lancashire boiler was unsuitable in all cases for electric lighting purposes. He was of opinion that if bituminous coals were used, the figure of merit of the Babcock-Wilcox and Lancashire boilers would probably be reversed, and bituminous coal was not to be thought altogether out of the running for electric lighting stations, since it had been demonstrated that it could be burned under proper conditions without causing smoke. Several purely mechanical engineers then addressed the meeting, one of them causing considerable amusement amongst the assembled electrical engineers by solemnly giving his vote against the use of high-speed engines for electric lighting purposes.

THE PACIFIC CABLE QUESTION.—The question of the proposed Pacific cable still continues to occupy the attention of submarine telegraph circles in this country. Within the last few months quite a shower of colonial representatives has descended upon this country, and have all with one accord endeavored to catch the public ear and open the public pocket on behalf of a British cable connecting Australia with Canada. The latest episode is a long letter to the "Times" from Sir John Pender, controverting certain statements recently made by Sir Charles Tupper, a colonial representative, at the Royal Colonial Institute. Sir Charles Tupper, as an instance of the long life which might be expected of a cable, stated that 30 per cent. of the present cables of the Eastern Extension Company were more than 20 years old. Sir John Pender points out that nearly the whole of that company's cables have been renewed in a considerably shorter period than 20 years. He also shows by actual instances that it is impossible to rely upon a normal annual increase of 12½ per cent. in the volume of traffic. The fact is that this proposed cable has next to no commercial raison d'etre, at present scarcely any strategic value, and, letting alone the probability of there being colonial politicians with axes to grind, sentiment, no doubt estimable, is alone the reason for the outcry for this new imperial toy. The great depth of the Pacific, which is so frequently held up as a source of safety in case of war, does not really add very much to the security of the cable should a determined enemy be intent upon cutting it. A cable can only be picked up with any degree of readiness, at depths over a few hundred fathoms, by men who have devoted their whole lives to the care of cables. Any greater depth, therefore, than a few hundred fathoms does not, from a strategic point of view, add appreciably to the value of a cable. The Canadian and Australian ends of this cable will not run immediately into deep water, so that the shore ends of this Pacific cable need to be watched by the ships of the nation owning it, in order to secure it immunity from irruption.

ENGINEERING AT CAMBRIDGE.—Professor Ewing's laboratory was opened at Cambridge on Tuesday by Lord Kelvin.

THE HEILMANN LOCOMOTIVE.—This much advertised locomotive is now regularly running a train from Paris to Mantes, a distance of 33 miles, performing the journey in 55 minutes.

News of the Week.

Telegraph and Telephone.

WASHINGTON, MO.—A. W. Tibbe has built a telephone line to Union.

LONDON, OHIO.—The City Council has granted to Thos. H. Roland a franchise for a magnetic telephone system.

ST. JOSEPH, MO.—The Citizens' Telephone Company is pushing its work to completion; its pole line is all set, and it has started stringing wires.

MIDDLETOWN, N. J.—R. H. Holmes, a brother of Superintendent W. J. Holmes, of the Western Union, is organizing a telephone stock company at Middletown.

Electric Light and Power.

EMPIRE, OHIO.—C. W. Nicholson will build an electric light plant.

HAMBURG, IA.—H. P. Smith is to establish a new lighting plant.

ST. JOSEPH, MICH.—The electric light plant has been destroyed by fire.

VICTORIA, TEX.—For information regarding the electric light plant address the mayor.

RACINE, WIS.—The Racine Common Council will readvertise for bids for electric lighting.

WELLINGTON, OHIO.—The matter of the municipal electric lighting plant is being discussed.

GRENADA, MISS.—The mayor may be addressed concerning the proposed electric light plant.

MOUNT AIRY, N. C.—An electric light plant is to be established, and the mayor may be addressed for information.

CUBA, N. Y.—It is stated that the propesed electric light plant for Cuba will soon be built to supply light for public and private use.

MACON, GA.—T. D. Tinsley was appointed permanent receiver on May 22 for the Macon Gas, Light and Water Company, by Judge Speer.

HOUSTON, TEX.—A resolution to issue $100,000 in bonds to provide for a municipal electric lighting plant has been referred to the board of public works.

ST. LOUIS, MO.—Councilman Albert Arnstein, member of the subway commission, reports to the commission that it would cost $1,000,000 to build suitable conduits.

HILLSBORO, TEX.—The electric light company, composed of local capitalists, has come to terms with the authorities, and will, within 45 days, begin work on its proposed electric light plant.

MONROE, LA.—The Monroe Waterworks and Light Company is putting in additional power in the shape of a 150-h. p. Armington & Sims engine, and will operate a new incandescent circuit at once.

WASHINGTON, IOWA.—The electric light plant has been leased by G. W. Benedict for a company in Liberty, Ind. It will take possession Aug. 1, and will rebuild and improve the present plant.

JAMESTOWN, N. Y.—A resolution has been passed authorizing the board of public works and the municipal lighting commission to make plans and specifications for the proposed additions to the municipal electric lighting plant.

READING, MASS.—The town of Reading has voted to reject the

offer of the Woburn Electric Company to supply electric light to the town, and will instead build a plant with a brick power station and 41 miles of wire, to cost $41,000.

ST. AUGUSTINE, FLA.—The General Electric Company, capital stock $50,000, has applied for incorporation to build and operate an electric light, heat and power plant. Wm. A. MacWilliams is president and J. A. Enslow secretary and treasurer.

MOUNT HOLLY, N. J.—The Citizens' Water Company, capital stock $75,000, has been formed, and the following are the committee in the matter of the proposed waterworks and electric light plant: Thomas J. Alcott, John D. Johnson, A. A. Anderson and Dr. C. R. C. Barrington.

SPRINGVILLE, N. Y.—It is stated that an artificial lake will be made here, and that power will then be supplied to the manufacturing industries of the town. An electric light plant is one of the probabilities. Messrs. King, of Delevan, and Scott, of Springville, are interested.

DU BOIS, PA.—The council of the borough of Du Bois wishes to contract for electric lighting, to be 40 or more electric lights of 1,200 candle power each, for a term of six years from Jan. 1, 1895, as per plans in the possession of the borough attorney, G. A. Lukehart. All bids are to be in by July 6, at 7 P. M. H. McCullough, D. J. Carson and F. A. Hatfield are the light committee.

ST. JOSEPH, MO.—Walter C. Stewart, formerly electrician of the People's Street Railway, Electric Light and Power Company, has been appointed electrical inspector. Heretofore St. Joseph has been without an inspector. His salary is paid partly by the city and partly by the Board of Fire Underwriters. William H. and Oliver Harriman, of New York, stockholders of the St. Joseph Traction and Lighting Company, are in the city seeing about increasing the lighting capacity of the plant this fall.

The Electric Railway.

RED BANK, N. J.—An electric road is proposed from Red Bank to Seabright.

SANDLAKE, N. Y.—The survey for the Troy and Sandlake Railway has been completed.

NEWARK, N. Y.—The Village Board is considering an application for right to build an electric railway on the streets here.

ELMIRA, N. Y.—The West Side Street Railway will in a few days begin the work of laying its lines in the eastern part of the city.

GRAND RAPIDS, MICH.—The North Park Street Railway Company has raised $75,000 on mortgage, to be devoted to improvements.

NEW BRITAIN, CONN.—Superintendent Breed, of the Electric Traction Company, will make extensions and improvements this spring.

OPELIKA, ALA.—The Opelika and Auburn Electric Railway Company is in the market for equipments. Address C. I. Daughtry.

KANSAS CITY, MO.—W. J. Smith is organizing a company to reconstruct and extend the East Fifth street railway. Electricity will be the motive power.

GREEN ISLAND, N. Y.—The petition of the Troy City Railway Company to change its motive power from horses to electricity is receiving many signatures.

APPLETON, WIS.—F. S. Maxwell, representing the Tillotson interest, is pushing the scheme for an electric road between Neenah and Kaukauna, via Appleton.

COHOES, N. Y.—Residents of the first, fourth and fifth wards met in Houlihan's Hall and discussed the matter of establishing a belt line railway over the hill.

WHITE PLAINS, N. Y.—A special committee, consisting of S. L. H. Ward and James B. Lockwood, are looking into the matter of a street railway for White Plains.

NEW BRUNSWICK, N. J.—The Board of Trade has expressed itself in favor of having the electric railroad ordinance, now pending, passed over the mayor's veto.

PUNXSUTAWNEY, PA.—There is a scheme being talked of to build an electric railway between Punxsutawney and Indiana, but no definite move has yet been made.

WILKESBARRE, PA.—The directors of the Wilkesbarre and Wyoming Valley Traction Company have decided to build the road up over the heights within 30 days.

WASHINGTON, D. C.—The Washington, Alexandria and Mt. Vernon Electric Railway Company has been authorized by Congress to lay tracks on certain streets.

PEEKSKILL, N. Y.—The New York "Mail and Express" states that the proposed electric street railway line for Peekskill has been abandoned, as the necessary capital could not be raised.

SOUTH KINGSTON, R. I.—The taxpayers have decided to oppose any attempt to locate an electric road in their town. They think it will injure the quiet humdrum respectability of the place.

WASHINGTON, MO.—A. W. Tibbe, proprietor of the Washington electric light plant, has extended his incandescent circuit to the neighboring town of Union, 10 miles distant, and will light up June 2.

AKRON, OHIO.—A company has been formed by Gen. Sam. Thomas, of New York; the Hon. Calvin S. Brice, U. S. Senator, and others, with a capital of $3,000,000, to build an electric line from Akron to Pittsburgh.

NEWBURGH, N. Y.—The petition of the Newburgh and Orange Lake Railway for right to build a street railway, will be heard May 29, at 7:30 P. M., in the common council's room. D. J. Countant is clerk of the council.

HONESDALE, PA.—In the matter of the proposed electric road between Honesdale and Hawley, D. J. Duncan, of Johnstown, who is connected with the Carbondale Traction Company, states that he will put $5,000 into the venture.

BLOOMFIELD, N. J.—The Bloomfield township committee has referred to a special committee the application of Frank W. Child, on behalf of the Suburban Traction Company, for leave to change its motive power from horses to electricity.

LEWISTON, N. Y.—It is stated on reliable authority that Contractor West will soon begin work on an electric line from Lewiston to Youngstown. A large number of Italian laborers now quartered in Lewiston gives color to the rumor.

SKOWHEGAN, MICH.—The matter of the proposed electric road from Skowhegan to Norridgewock is again being agitated. Amos F. Gerald, Hon. I. C. Libby and S. A. Dinsmore have been looking over the ground, and steps will soon be taken.

ST. AUGUSTINE, FLA.—The St. Augustine Electric Railroad Company is preparing to build an electric plant at North Beach to operate its road. The company will extend the road 4½ miles, and is in the market for cars and electric supplies.

BALTIMORE, MD.—President Nelson Perin, of the City and Suburban Railway, has asked the authorities for permission to extend the company's tracks from the present terminus at Point Breeze to Sparrow's Point, and the matter is under deliberation.

PINE BLUFF, ARK.—The Citizens' Street Railway Company has been sold to a Cincinnati company, of which K. P. Bradford will be president and general manager, but the board of directors will be chosen in Pine Bluff. The entire line will be improved and electric power adopted.

BLOOMFIELD, N. J.—At a meeting of the Bloomfield township committee the Central Jersey Traction Company asked for a franchise to build a trolley line from the Montclair line to the Newark line through Bloomfield avenue, and the petition was referred to the committee on franchises.

PITTSBURGH, PA.—The committee on corporations, of Allegheny, Pa., has granted to the Union Line permission to extend its line from Wood's Run avenue to Watson Park. The Allegheny Traction Company has also been granted permission to build an electric line on Spring Garden avenue.

PHILADELPHIA, PA.—The Manayunk, Roxborough and Wissahickon Inclined Plane Railway Company has awarded to Stern & Silverman the contract for building the new power house at Shawmont, and the full equipment of the road from Wissahickon to Barren Hill, the work to be finished within 60 days at a cost of $60,000.

HACKENSACK, N. J.—Alfred C. Zabriskie is before the Hackensack Improvement Commission in the matter of getting a franchise for his proposed street railway, but he refuses to specify the power, barring only steam, which he guarantees not to use. He has been asked to make a definite request, and the matter will then be considered.

WASHINGTON, D. C.—Sealed proposals will be received at the office of the commissioners of the District of Columbia to 2 P. M., June 7, for relaying with grooved rails so much of the Columbia Railway tracks as may be necessary, in accordance with specifications and blank forms of proposals on application to J. W. Ross, Geo. Truesdell and C. F. Powell.

ELIZABETH, N. J.—The Suburban Electric Street Railway Company, through its attorney, B. V. Lindabury, has applied to the Board of Freeholders for permission to lay tracks between Elizabeth and Plainfield and Westfield. At the next meeting of the board a date will be fixed for a public hearing, and there is no doubt that much opposition will arise.

NASHVILLE, TENN.—General Jackson, president of the Nashville Street Car Company, states that he has made a five-year contract with the Cumberland Electric Light and Power Company, by which the company will furnish power to operate the street cars. The Cumberland Electric Light and Power Company will take over the plant of the old United Electric Company, and improve and extend the same.

HARTFORD, CONN.—D. F. Keenan, of Meriden, Conn., has signed a contract with the Hartford Street Railway Company to build extensions to Windsor, Pequomock and Rainbow, and perhaps to South Windsor. His contract does not call for doing the overhead work. Mr. Keenan is one of the owners of the Meriden Railway system.

APPLETON, WIS.—D. W. Stroud, Norman McCarthy, T. S. Maxwell and F. E. Cole contemplate building an electric railway

from Oshkosh to Kaukauna, via Neenah and Appleton. The County Board of Outagamie County will pass on the matter of a franchise at a special meeting in June, and work will be begun at the earliest possible moment.

WILMINGTON, DEL.—The Wilmington City Electric Company is negotiating for the purchase of the Riddle's Mills site, on the Brandywine, 1½ miles from the centre of the city, and the present lighting station for the generating of electrity for light and manufacturing needs. The water power at the location is 300 h. p., which is considered ample for the company's needs. The city lights will get their electricity from the new plant. The company has secured the city lighting for another term at a reduced rate.

Miscellaneous Notes.

THE CORRESPONDENCE SCHOOL OF TECHNOLOGY, of Cleveland, Ohio, has issued a catalogue containing a description of the various courses taught, with portions of correspondence papers to illustrate the methods pursued. A full explanation of the scope and object of the school is given, and its manifest advantages pointed out. The high technical standing of the members of the faculty, and the fact that all are engaged in commercial work, are two points of importance brought out.

THE ROSE POLYTECHNIC INSTITUTE, Terre Haute, Ind., though one of the youngest of the institutions which have established electrical departments, has enjoyed unusual success. While its plan of education insists upon and fully develops the theoretical side of the instruction, and includes the modern languages as well, it lays especial emphasis on the practical side of technical education, as it is able to do throughout the whole course of four years by reason of ample shops, drafting rooms and laboratories, and an exceptionally complete outfit of instruments of precision.

PENNOCK AGAIN.—The "Universal Magazine," a new monthly publication of Boston, discounts its future by devoting a page and a half of its April issue to G. B. Pennock, accompanied by a full page portrait—and a full page advertisement. It is announced that "the Pennock system can put 20 h. p. in a boat and deliver 100 h. p.; yes, 200 h. p.—at the propeller shaft." The advertisement concludes with a statement that a limited amount of the Pennock stock is now offered in lots to suit investors, and we learn that Riverton, N. J., is now one of the bases of operation.

FREE ELECTRICITY.—Mr. Fremont Wilson, in a letter to the "Standard," a journal devoted to the underwriters' interests, states that in Brooklyn there are places where people are using escaped current from the trolley lines and ground connections for the purpose of running motors and furnishing current to lights, attaching their wires to the water pipes for one connection and to the elevated railway structure for the other. He says that in a store window in that city there is a motor running connected in this manner, and that it has been brought to his attention that one of the telephone exchanges in a suburban district intends to use a motor dynamo for the purpose of running the telephone exchange, it being intended to use the ground connections and escape current from the trolley line for the purpose of operating the motor, and then use the current which is developed from the generating end of the armature of the motor dynamo for the purpose of supplying current to the telephone exchange, thus doing away with batteries. Mr. Wilson adds that it has been broadly intimated to him that this plan is being tried in a telephone station not a very great distance from New York City.

ELECTRIC HEATING.—In a paper recently read by Mr. W. S. Hadaway, Jr., before the New York Electrical Society, on "Electric Heating from the Engineering Point of View," it is shown that electric street car heaters only cost 5 cents per day more than coal stoves, the figures being 20 and 15 cents, respectively. It is stated that present installations of cooking apparatus demonstrate the success of electric cooking, both as regard cost and simplicity of operation. An installation in this city operating since Jan. 1 has proven conclusively that theoretical deductions are not far fetched, and that electric cooking can no longer be regarded as an experiment or a fad. This plant consists of oven of two compartments, broiler of three sections, portable stoves of various sizes, teakettle and farina boiler, which have heaters directly attached to them, and plate warmer. The cooking operations are carried on beneath a hood ventilated by a fan driven by a motor, and the kitchen is very comfortable as a dining room. At the rate of 5 cents per horse power hour, the cost per person per day is about 2 cents. At the rate of 2½ cents per horse power hour, which may be considered a fairly representative price from water power stations, cost per person per day would be about 1 cent, and from an isolated plant, directly operated, cost per person per day would be about 2-5 cent. Electric cooking is therefore far cheaper than cooking by gas or stoves, excluding the water boiling factor, which is more expensive. Heating houses by electricity is pronounced impracticable, and it is stated that for space heating coal at $5 per ton, burned under a good boiler, and distributed throughout the building by direct steam, is on a parity with the electrical horse power at $4 per year, while there is no instance where power can be sold at this rate; in fact, interest cost on an electrical plant usually equals this amount.

Trade and Industrial Notes.

THE CHICAGO INSULATED WIRE COMPANY has moved its office to Rooms 414 to 416, Northern Building, corner of Lake and La Salle streets, Chicago.

CHAS. C. CALDWELL, electrical and mechanical engineer, has removed from Springfield, Ohio, to Shelbyville, Ind., where his address is 82 West Broadway.

THE AMERICAN CIRCULAR LOOM COMPANY announces that it removed its offices to its factory, Highland and Suffolk streets, Chelsea, Mass., on May 22, 1894. The present postal address is Chelsea Station, Boston, Mass.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, Havemeyer Building, New York, has accepted the resignation of A. W. Field as vice president, and elected H. C. Soop, of Kingston, to the vacancy thus created. Mr. Field will take charge of the Boston office.

THE BOSTON GEAR WORKS, 31 Hartford street, Boston, has issued its 1894 catalogue, containing 40 pages of lists, illustrations and information relating to gears. A specialty of this firm is that of cutting all kinds of gears to order and furnishing gears for experimental work.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, has issued a revised price list of the Fleming woven wire gauge dynamo brushes, which are so largely used in central stations, and have been adopted by the United States, English and Brazilian navies.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has devised a special globe net for arc lamps to meet the requirements of underwriters. The company also reports the sale of a large number of complete Mogul lamp equipments for theatre and hall lighting during the past week, in addition to several outfits for outside work, as a substitute for arc lamps.

THE ELECTRICAL ASSOCIATION, INC., of Waterbury, Conn., has placed the contract for its new power station with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be 66 feet in width and 183 feet in length, the side walls of brick and the roof covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron.

THE PRICE RAILWAY APPLIANCE COMPANY, 125 South Fifth street, Philadelphia, have recently placed on the market a new copper bond, which affords 90 square inches of contact with the two rails, and which is offered as a substitute for the inadequate bonding with rods from ⅛ to 9-16 inch in diameter, and of a length varying from 10 to 30 inches.

THE WESTON ENGINE COMPANY, Painted Post, N. Y., sends us a handsomely printed and bound catalogue containing an unusually clearly written technical description of the various parts of the Weston automatic engine, and illustrated by a number of beautifully executed cuts by Bartlett. Rules for calculating the horse power of indicator cards and a list of Weston engine constants are appended.

THE BUILDERS' IRON FOUNDRY, Providence, R. I., has recently successfully cast one-half of the General Electric Company's 450,000-watt alternating current dynamo. This is a difficult piece of work, as 10 laminated iron pole pieces have to be cast in, and it is essential that they be absolutely united with the cast iron and accurately spaced. The Builders' Iron Foundry is particularly successful with this class of work.

THE CREAGHEAD ENGINEERING COMPANY, 296 Plum street, Cincinnati, Ohio, has issued a catalogue, consisting of 24 large pages, and containing illustrations, descriptions and prices of electric railway overhead parts. A very complete line of trolley fittings is shown, as well as station and line switches, lightning arresters, line material and arc lamp pulleys. A complete cipher code is given for ordering material by telegraph.

M. T. DAVIDSON, 43-53 Keap street, Brooklyn, has issued a handsomely bound volume of 118 pages, containing descriptions and cuts of the numerous types of Davidson pumps. The variety of uses to which this design of pumps is adapted is illustrated by a list of no less than 34 different kinds that are manufactured. Some 20 pages of the book are devoted to useful information for engineers, including table of areas of circles, friction losses in water pipes and steam data.

THE CORLISS STEAM ENGINE COMPANY, a newly organized corporation, has purchased the extensive works of the Geo. H. Corliss Steam Engine Company, of Providence, R. I., and the business, which has been partly suspended since the death of Mr. Corliss, about 18 months ago, will again be actively resumed. The company will build the Corliss engine in all of the different styles, i. e., condensing, non-condensing, single or in pairs, compound and triple expansion, in sizes from 50 to 3,000 h. p., and also the Corliss patent vertical tubular water leg boiler. The new organization has retained all the heads of departments employed and trained by Mr. Corliss. The officers of the company are: D. M. Thompson, president and treasurer, for the past 12 years general manager of B. B. & R. Knight's mills; Stephen A. Jenks, vice president, treasurer Fales & Jenks Machine Company, Pawtucket, R. I.; Wm. B. Sherman, secretary; L. H. Wattles, superintendent, and Charles E. Giles, agent, formerly superintendent and agent of the Corliss Steam Engine Company.

THE OERLIKON COMPANY, of Switzerland, has issued a handsome pamphlet concerning its alternate current machines, with stationary armatures, for both single phase and multiphase currents. The advantages of such dynamos and motors are briefly pointed out, and quite a number of illustrations are given, not, as is usual, showing simply the external appearance of the machine, but giving instead sections and detailed views, as also a large 600-h. p. high tension alternator of a horizontal type, driven directly by a turbine. A table of the principal data is given for single phase and three phase alternators, the normal frequency for which appears to be 50. The efficiencies reach 94 and 95 per cent. in the largest machines, which for the three phase current had an output of 700 kw. A list of the principal installations of these large machines is given, among which are 17 for the three phased current, aggregating 24 machines of a total of 3,710 h. p., in several of which 5,000 volts are used, including one in which 750 h. p. is transmitted. The single phased system is used chiefly for lighting, while the three phased is used almost exclusively for power transmission.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

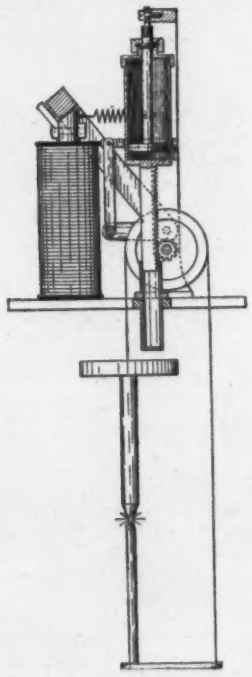
U. S. PATENTS ISSUED MAY 15, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

519,726. ELECTRIC ARC LAMP; W. Mathiesen, Leipsic, Germany. Application filed May 29, 1893. This comprises a fixed piston, a rack bar attached to one end of the cylinder, a pinion operated by the rack, and a carbon holder actuated by the pinion. (See illustration.)

519,794. ELECTRIC RAILWAY SYSTEM; D. Mason, Schenectady, N. Y. Application filed June 27, 1893. This comprises main and branch conductors connected with switching levers in alignment with the rails of the track, and adapted to be actuated by the wheels of the vehicle, and short sectional conductors provided with circuit connections for connecting them to the branch conductors.

519,813. ELECTRICALLY GOVERNED SWITCH; E. H. E. Klatte, Freiburg, Baden, Germany. Application filed Feb. 29, 1892. The combination of a railway track, a switch tongue, an electric motor connected with the switch tongue for actuating it, a pole changer for the motor, an electric switch disposed near the pole changer, a circuit breaker, mechanism connecting the breaker with the switch mechanism and conducting wires leading from the pole changer and reversing switch to the motor and circuit breaker.



NO. 519,726.—ELECTRIC ARC LAMP.

519,837. TROLLEY WHEEL; V. N. Cruser, Flatbush, N. Y. Application filed Feb. 13, 1894. A trolley wheel formed of two parts mounted for movement in the same direction at different rates of speed.

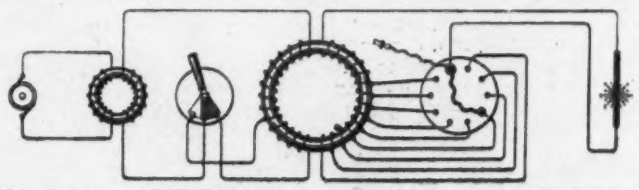
519,849. ALTERNATING CURRENT ARC LIGHTING SYSTEM; T. Spencer, Philadelphia, Pa. Application filed Feb. 12, 1894. This comprises a switch for coupling a variable number of turns of a transformer winding in the lamp circuit, and means for lowering the voltage after the lamp has been thrown into action. (See illustration.)

519,858. CONSTANT CURRENT DYNAMO; W. H. Elkins, Cambridge, Mass. Application filed Feb. 3, 1894. This comprises a compound wound field, positive and negative terminals and means for moving the brushes about the commutator.

519,862. METHOD OF, AND MEANS FOR, STARTING SYNCHRONOUS MOTORS; B. G. Lamme, Pittsburgh, Pa. Application filed April 5, 1893. The combination of a constant potential alternating current system, and a mutiphase self-exciting synchronous motor; with a converter for each phase of the current having its primary in circuit with the main leads and its secondary in circuit with the motor armature and means whereby the potential of the secondary circuits may all be symmetrically varied.

519,869. ELECTRIC MECHANISM FOR GIVING RECIPROCATING MOTION; H. S. McKay, Boston, Mass. Application filed March 12, 1892. This comprises a movable contact, fixed contacts for engagement therewith and electric connections between the contacts.

519,870. MAGNETIC ENGINE FOR RECIPROCATING TOOLS; H. S. McKay, Boston, Mass. Aplication filed July 5, 1892. This consists of two or more solenoids and a plunger adapted to be reciprocated by them.



NO. 519,849.—ALTERNATING CURRENT ARC LIGHTING SYSTEM.

519,876. TELEPHONE CIRCUIT; C. E. Scribner, Chicago, Ill. Application filed Sept. 28, 1893. This comprises induction coils having secondary helices connected in parallel branches of the telephone circuit, two in each branch, and their primary helices in circuit with a common microphone, a receiver having one terminal connected to each branch between the two induction coils thereof, one secondary helix in each branch, upon opposite sides of the telephone terminal, being constructed to have high impedance.

519,881. DEVICE FOR REGULATING ELECTRICITY GENERATED BY MEANS OF WIND POWER; T. A. Willard, Norwalk, Ohio. Application filed April 6, 1893. This consists of a regulator consisting of a soft wound core, a cross bar, an armature pivoted to the cross bar, switch lever movable with the armature, a spring engaging the pivoted end of the switch lever, segments over which the switch lever moves and with which its free end contacts, and resistance coils connecting the segments.

519,912. ELECTRIC ARC LAMP; J. F. Kester, Buffalo, N. Y. Application filed Oct. 23, 1893. This comprises a frame and magnet, carbon rod, armature lever hinged to the frame, a spring to elevate the lever, a gripping plate suspended from the armature in such manner as to permit one end to raise and descend, and a cam stop rotatably secured on a post for limiting the elevation of the armature lever.

519,932. ELECTRIC RAILWAY SIGNAL; R. M. Strong and C. F. Reed, Omaha, Neb. Application filed Sept. 5, 1893. This comprises two pairs of independent conductors and means whereby a current in any section of the first pair will open-circuit breakers in a corresponding section of the second pair.

519,938. ELECTRIC RAILWAY SIGNAL; F. Beattie, Leete Island, Conn. Application filed April 2, 1894. This comprises an alarm bell, a reciprocal and rotatable rod controlling the making and breaking of the circuit of the bell, a plunger, a button secured to the lower end of the rod and connecting the plunger thereto, and a pivotal trip adapted to be operated upon by a tripping device applied to the railway and constructed to be coupled with the rod through the medium of the button.

519,945. ELECTRIC INDICATOR; W. E. Garey, Chicago, Ill. Application filed Oct. 13, 1893. The combination of an electromagnet and an armature having a portion pivoted to the field of one pole of the magnet, and a portion located in the field of the other pole of the magnet and extending laterally from the first portion.

Copies of the specifications and drawings complete of any patent mentioned in this record---or of any other patent issued since 1886---can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 253 Broadway, New York.